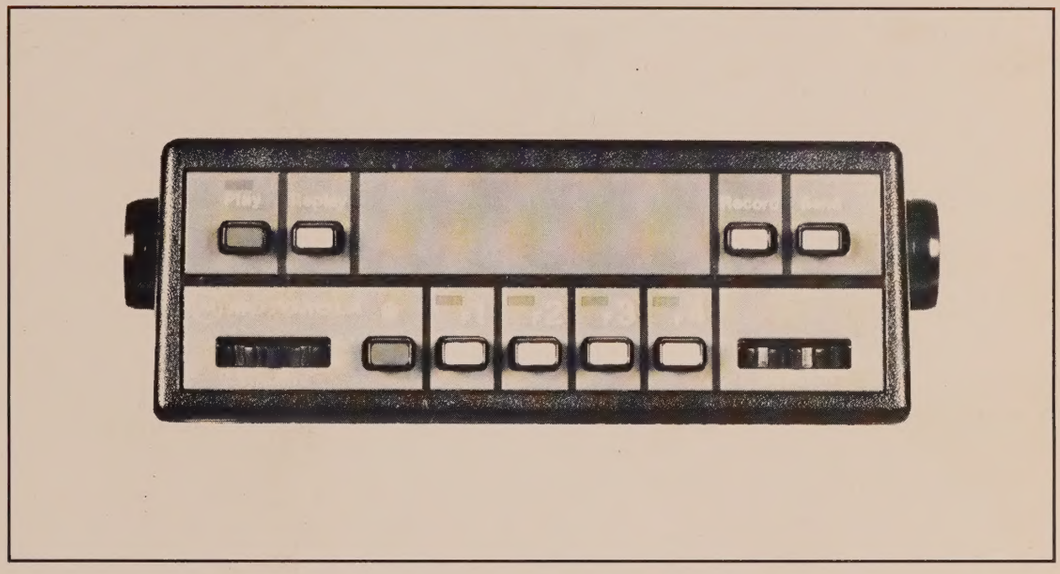
MOTOROLA

# *MVS-20* MOBILE VOICE STORAGE

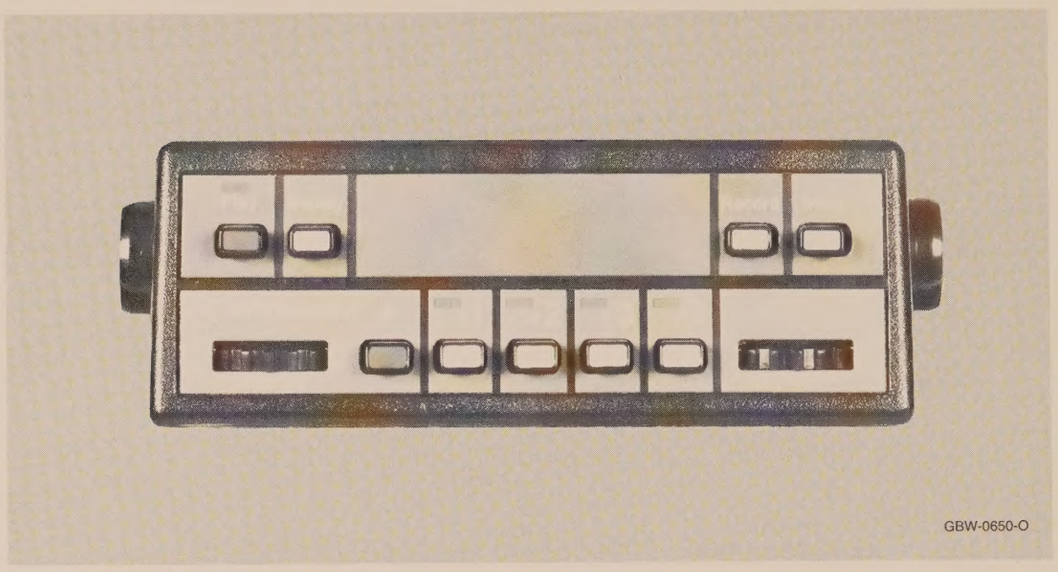
## with *MDC-600* Signaling System



## Instruction Manual

68P80100W50-O

# OPERATION




### TO TURN ON THE EQUIPMENT

Turn on the radio in the usual way. The *MVS-20* comes on with the radio and you hear the power-on beep.

### TO TRANSMIT CONVENTIONALLY

Listen for a clear channel, push the PTT button on the microphone, and speak into the microphone in the usual way.

### TO RECORD A MESSAGE

Push in the RECORD button, push the PTT button on the microphone, wait for the record mode beep, and then speak into the microphone in the usual way. (If you hear a series of beeps when you push in the RECORD button or when you push the PTT button, the *MVS-20* has one or more base recorded messages awaiting review, and will not allow you to record until you have listened to them.) When you release the PTT button, *MVS-20* plays back what you have recorded so far. If you want to add to what you have recorded, merely push the PTT button and speak again. The *MVS-20* adds this to what you have already recorded. When you have used a total of twenty seconds of recording time, a series of beeps sounds and recording ceases. If you then push the PTT button again (with the RECORD button in), you erase whatever has been recorded and start afresh.

### TO NOTIFY THE BASE THAT A MESSAGE IS AVAILABLE FOR RETRIEVAL

Push the SEND button. (In *Mitrek*, monitor for a clear channel first.) A beep indicates that the base station has received the indication that your message is waiting.

### TO REVIEW RECORDED INCOMING MESSAGES

The light above the PLAY button indicates that the base has recorded one or more messages into your mobile unit (a maximum of eight is possible). To hear a base-recorded message, push the PLAY button. Push the PLAY button again to retrieve another, if there is another. To repeat the last message reviewed, push the REPLAY button. (The light goes out and a beep sounds when you have reviewed the last message.) You can listen to all messages recorded or the last message reviewed as often as you wish, simply by pushing either of the buttons again—as long as the messages have not been erased.

### FOR ADDITIONAL INFORMATION

For additional information, see the Description Section of this manual.

MOTOROLA INC.
Communications
Group

# *MVS-20* MOBILE VOICE STORAGE

**with *MDC-600* Signaling**

## CONTENTS





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# MODEL CHART FOR *MVS-20* MOBILE VOICE STORAGE

**CODE:**

- ● = **ONE ITEM SUPPLIED**
- ✱ = **ITEM IS REQUIRED FOR *MVS-20* WITH *MITREK*, BUT IS NOT PART OF THE HLN1126A KIT (ALSO TO BE USED FOR FIELD RETROFIT)**

| MODEL | DESCRIPTION |
|---|---|
| HLN1117A | *MVS-20 SYNTOR/SYNTOR X* |
| HLN1126A | *MVS-20 MITREK* |
| HLN1145A | *SYNTOR MVS* RETROFIT |
| HLN1146A | *SYNTOR X MVS* RETROFIT |

| HLN1117A | HLN1126A | HLN1145A | HLN1146A | ITEM | DESCRIPTION |
|---|---|---|---|---|---|
| ● | ● | | | HLN4535A | *MVS-20* MOBILE BOARD |
| ● | ● | | | HLN4537A | PROM KIT |
| ● | | | | HLN4538A | HARDWARE & ESCUTCHEON KIT (*MVS SYNTOR, SYNTOR X*) |
| | ● | | | HLN4582A | HARDWARE & ESCUTCHEON KIT (*MVS MITREK*) |
| ● | ● | | | HKN4045A | MICROPHONE CABLE KIT |
| ● | ● | | | HKN4145A | *SYSTEMS 90/90•S* HOUSING CABLE KIT FOR *MVS* |
| | | ● | | HLN4373A | *SYNTOR* CHANNEL SENSE BOARD |
| | | ● | | HKN4159A | *SYNTOR MVS* RETROFIT CABLE |
| | | | ● | HLN4270B | *SYNTOR X* INTERFACE BOARD |
| | | | ● | HKN4160A | *SYNTOR X MVS* ADAPTER CABLE |
| | ✱ | | | HLN4573A | *MITREK* MUTING BOARD |

MXW-0660-O

# FOREWORD

## 1. Scope of Manual

This manual is intended for use by experienced technicians familiar with similar types of equipment. It contains all service information required for the equipment described and is current as of the printing date. Changes which occur after the printing date are incorporated by Instruction Manual Revision (WMR). These WMR's are added to the manuals as the engineering changes are incorporated into the equipment.

## 2. Model and Kit Identification

Motorola products are specifically identified by a model number on the nameplate. In most cases, assemblies and kits which make up the equipment also have kit model numbers stamped on them. When a production or engineering change is incorporated, the applicable schematic diagrams are updated.

## 3. Service

Motorola's National Service Organization offers one of the finest nationwide installation and maintenance programs available to communication equipment users. This organization includes approximately 900 authorized Motorola Service Stations (MSS) located throughout the United States, each manned by one or more trained, FCC-licensed technicians.

These MSS's are independently owned and operated and were selected by Motorola to service its customers. Motorola maintenance is available on either a time and material basis or on a periodic fixed-fee type arrangement.

The administrative staff of this organization consits of national, area, and district service managers and district representatives, all of whom are Motorola employees with the objective to improve the service to our customers.

Should you wish to purchase a service contract for your Motorola equipment, contact your Motorola Service Representative, or write to:

National Service Manager
Motorola Communications and Electronics, Inc.
1303 E. Alonquin Road
Schaumburg, Illinois 60196

## 4. Replacement Parts Ordering

Motorola maintains a number of parts offices strategically located throughout the United States. These facilities are staffed to process parts orders, identify part numbers, and otherwise assist in the maintenance and repair of Motorola Communications Group products.

Orders for all parts *except* crystals, active filters, code plugs, channel elements, and *Vibrasender* and *Vibrasponder* resonant reeds should be sent to the nearest area parts center. Orders for instruction manuals should also be sent to the area parts center.

When ordering replacement parts or equipment information, include the complete identification number. This applies to all components, kits, and chassis. If the component part number is not known, the order should include the number of the chassis or kit of which it is a part, and sufficient description of the desired component to identify it.

Orders for crystals, channel elements, active filters, PROM's, code plugs, and reeds should be sent directly to the factory address listed on the following page. Crystal and channel element orders should specify the crystal or channel element type number, crystal and carrier frequency, and the chassis model number in which the part is used.

Orders for active filters, PROM's, code plugs, and *Vibrasender* and *Vibrasponder* resonant reeds should specify type number and frequency, should identify the owner/operator of the communications system in which these items are to be used, and should include any serial numbers stamped on the components being replaced.

7. When soldering, be sure the soldering iron is grounded.

8. Prior to connecting jumpers, replacing circuit components, or touching CMOS pins (if this becomes necessary in the replacement of an integrated circuit device), be sure to discharge any static buildup as described in Procedure 1. Since voltage differences can exist across the human body, it is recommended that only one hand be used if it is necessary to touch pins on the CMOS device and associated board wiring.

9. When replacing a CMOS integrated circuit device, leave the device in its metal rail container or conductive foam until it is to be inserted into the printed circuit module.

10. All low impedance test equipment (such as pulse generators, etc.) should be connected to CMOS device inputs after power is applied to the CMOS circuitry. Similarly, such low impedance equipment should be disconnected before power is turned off.

11. Replacement modules shipped separately from the factory will be packaged in a conductive material. Any modules being transported from one area to another should be wrapped in a similar material (aluminum foil may be used). NEVER USE NONCONDUCTIVE MATERIAL for packaging these modules.

# DESCRIPTION

## 1. System

The *MVS-20* system records messages in selected mobiles or groups of mobiles, and retrieves recorded messages from them. A typical system consists of a console unit (connected to a base station) and one or more mobile units. This processor-based system, which uses *MDC-600* signaling, performs all data and control transmissions in software.

### 1.1 MOBILE UNIT

1.1.1 The signaling system uses PSK modulation and demodulation at 600 bps on a 1500-Hz carrier. It transfers data in bursts or "packets" 290 milliseconds long. The sensitivity of the system is equal to or better than the sensitivity required for the reception of intelligible voice. Special coding techniques detect and correct errors so that falsing rates are extremely low.

1.1.2 The mobile unit is a single *Systems 90* circuit board consisting of an MC3870 microcomputer, a PROM codeplug, PSK filtering, regulated power supplies, switches, and indicator lights. The processor performs all of the PSK modulation, demodulation, encoding, and decoding. It also performs all of the control logic and management functions of the mobile system. A single *MVS-20* board can record a total of eight messages (originating in the mobile, or being received by the mobile, or a mixture of both), with a total duration of 20 seconds.

1.1.3 The system can address up to 9,999 unique unit identification codes, 99 group codes, and ten fleet codes. Each mobile is programed with a unique unit number and a group number and fleet number. These numbers are used to identify and address the mobile units. All data packets contain the unit number or a combination of group and fleet numbers.

1.1.4 *MVS-20* units have a special detection algorithm to mute the audio during any data reception. This feature improves the audibility of voice/data systems, making the data nearly "transparent" to listeners monitoring the channel.

1.1.5 Acknowledgment and retransmission logic makes the basic functions reliable and automatic. The receiving unit acknowledges certain commands issued from the mobile or base unit automatically. The *MVS-20* console retransmits certain commands automatically for a total of five transmissions if it does not receive an acknowledgment.

1.1.6 All voice storage and retrieval is done on the mobile card with a Continuously Variable Slope Delta (CVSD) coding technique, This technique allows the analog audio signals to be digitized and stored as a serial bit string in dynamic RAM. Only the mobile units store the voice messages, and the mobile units convert all messages retrieved by the base from serial bits to reconstructed audio before transmitting them.

### 1.2 PROGRAMING THE SYSTEM

Many of the major features or configurations of the system are selected through PROM's. These PROM's also contain various system parameters.

An optional PROM programer for the *MVS-20* console unit programs mobile unit ID codes (unit, group, and fleet numbers) and system delays. With it the operator may set up his own system codes without help from Motorola. System functions, however, are preprogramed at the factory.

Also available to program PROM's in the field is the R1801A Digital Analyzer/Programer. With it the operator can program system codes as he can with the *MVS-20* PROM Programer, and can also program system functions or modify them for special applications.

It is often necessary to delay the transmission of the *MVS-20* data packet by a length of time that depends on the configuration of a particular system—which may include repeaters, PL/DPL control, remote receivers, transmitters, etc. The system delay can be programed into the mobile from data in the console unit. It may range from 0 to 1.5 seconds in steps of approximately 100 milliseconds. The delay is in the form of a silent carrier and is programed automatically with the ID numbers and muting modes. It is the same as the delay programed into the console.

## 2. Operation

### 2.1 SYSTEM FUNCTIONS

#### 2.1.1 Normal Transmission from Mobile Units

Unless the RECORD switch is latched in, the mobile operator can transmit in the usual way by

pushing the PTT and talking into the microphone. The radio transmits in the usual manner, whether or not there are messages stored in the mobile unit's memory.

2.1.2 Mobile-Initiated Record (RECORD)

The operator selects the record mode by pushing in the the RECORD button until it latches. He then pushes the PTT button and speaks into the microphone, and the unit records what he says. When he releases the PTT, the entire message plays back automatically. If he pushes the PTT and speaks again, the memory adds the new message onto his previous message. It continues to add whatever the operator says into the microphone whenever he pushes the PTT and the RECORD button is in. When the recorded messages total 20 seconds, two beeps sound, and recording ceases. The next time the operator pushes the PTT button with the RECORD button in, however, he automatically clear all memory and starts afresh.

If the memory contains a message received from the base station and not yet reviewed by the mobile operator, and if the operator attempts to record a message—or merely put the unit into the record mode—the alert tone beeps until the operator takes the unit out of the record mode (or until it has beeped 15 times). Releasing the PTT switch also ends the beeping.

The operator takes the unit out of the record mode by pushing and releasing the RECORD button.

2.1.3 Request for Service (SEND)

The mobile operator uses the SEND button to inform the base that he has a message that is ready for review by the base. When he pushes this button (after he has recorded a message for the base), the unit sends a data packet to the base. When the base receives this packet, it transmits an acknowledgement packet that sounds a single tone burst in the mobile speaker. If the "request for service" packet does not reach the base or the acknowledgment packet does not reach the mobile, there are no automatic retransmissions. Therefore, if the mobile operator does not hear a beep soon after pushing the SEND button, he should push it again.

*SYNTOR* and *SYNTOR X* radios sense a busy channel and automatically wait for the channel to clear before sending a data packet. The *Mitrek* operator should monitor the channel before pushing the SEND button.

2.1.4 Retrieval and Review of Recorded Messages from Base (PLAY, REPLAY)

The base can send messages to the mobile and have the mobile record them. (The mobile will record the messages whether its RECORD button is in or out). The mobile can record a maximum of eight messages or a total of 20 seconds of messages from the base. If the base operator makes the mobile unit record a ninth message, the mobile erases (discards) the first. When the mobile receives the first message from the base, the "message waiting" lamp (above the PLAY button) lights. This lamp then remains lighted until the mobile operator has reviewed all messages from the base. To review messages, the mobile operator pushes the PLAY button. To play the last message again for clarification or to permit the operator to write down information it contains, the operator pushes the REPLAY button. He may review the recorded messages as often as necessary. Because the storage is digital and not mechanical, the unit replays the message immediately, without having to pause for mechanical rewinding.

**NOTE**

Under certain conditions (low humidity, high-dielectric seat covers), the operator may accumulate a static charge. This may discharge to the *MVS-20* when he operates it. Such a discharge, although it will not damage the *MVS–20,* may causes its computer to reset. This erases all memory, and also causes a warning beep to sound.

2.1.5 Erase

Under normal operating conditions the mobile operator has no need to erase stored voice messages, and the mobile unit does not have an ERASE button or other provision for clearing the memory. There are two conditions, however, that cause complete erasure. One is loss of power, which depletes the circuitry of the energy it must have in order to maintain memory cell status. The other occurs when the mobile operator has used the entire 20 seconds of voice storage capacity, at which time recording stops (without erasure) and warning tones sound in the mobile speaker. When the mobile operator releases the PTT switch, the tones stop and the twenty-second mobile-originated message plays back automatically. If the the operator pushes the PTT switch again without disengaging the RECORD switch, he erases the entire memory, and the unit is ready to record again.

The base operator should erase mobile-originated messages once he has retrieved them. Once the mobile operator has retrieved a base-originated message, it no longer prevents him from using storage in his unit. Because he must retrieve all previously unretrieved messages from the base before doing any recording at his unit, he has the full eight-message, 20-second capacity of the system at his disposal whenever he starts to record.

# INSTALLATION

## 1. *Mitrek*

### 1.1 GENERAL

The *MVS-20* system can be either a field-installed add-on or a factory-installed option for a *Mitrek* radio with the *Systems 90* alternate control module. The *MVS-20* circuit board is installed in the accessory housing, either alone or in combination with other *Systems 90* accessories. These installation instructions apply when the *MVS-20* is the only accessory. (For multiple installations, refer to the installation instructions supplied with the housing assembly.) When *MVS-20* is the only accessory, it should occupy the upper part of the accessory housing, and the alternate control module should be in the lower part.

### 1.2 HLN4573A Discriminator Mute Board

The HLN4573A mutes the discriminator buffer in *Mitrek* radios during playback of recorded messages. This reduces the amount of discriminator noise feedthrough that gets on the receive audio. It is factory installed in new radios, and must be added to older radios in the field. It is mounted inside the radio housing on a boss near the front of the transmitter section. (See Figure 1.)

For radios without *MDC-600* options, three wires connect the discriminator mute board to the *Mitrek* radio. Two of the wires solder into holes left when R453 is removed. The third wire (equipped with a jumper clip) is attached to a jumper position on the radio interconnect board.

Radios with both *MVS-20* and *MDC-600* options use a fourth wire (equipped with an individual push-pin connector) that plugs into the TX switch 9.5V pin at P4.

### 1.3 FIELD-INSTALLED ADD-ON

1.3.1 To install the *Systems 90 MVS-20* circuit board, follow these steps:

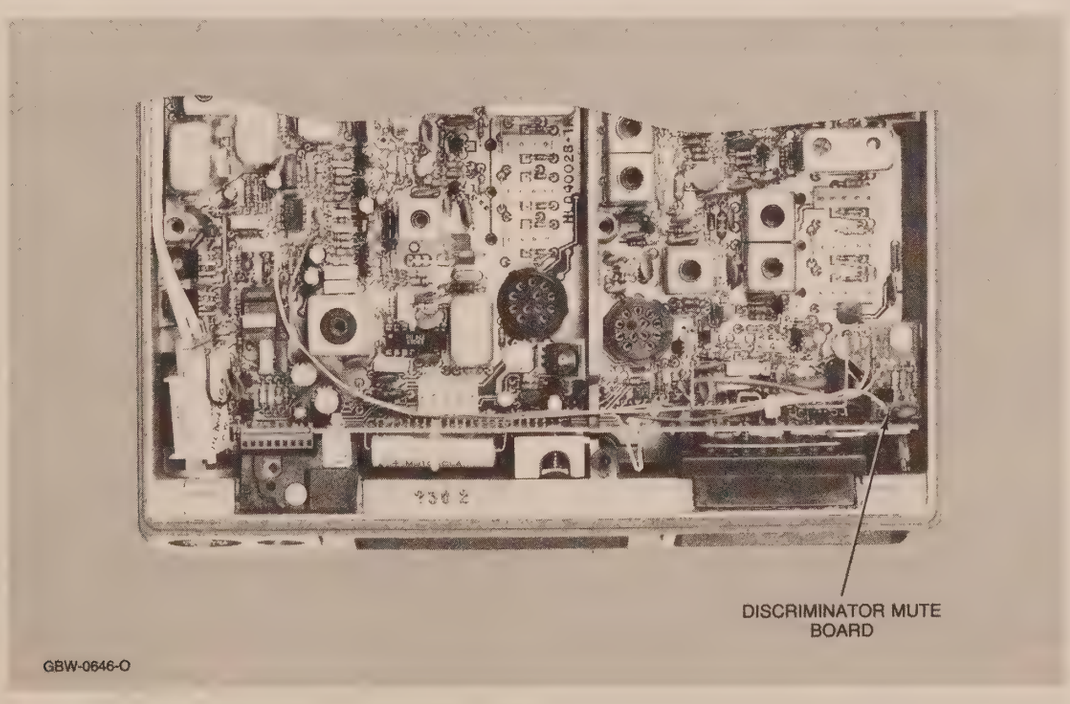



*Figure 1. Discriminator Mute Board in* ***Mitrek*** *Radio*

(1) Disconnect all connectors from the alternate control module.

(2) Loosen the two captive screws on the bottom of the housing and remove the rear cover.

(3) Remove the escutcheon, if there is one, from the upper front panel. Separate the *MVS-20* escutcheon from the backing and place it carefully over the upper front panel, making sure the escutcheon holes are aligned with the holes in the panel. Press it firmly into place.

(4) Remove all the knockout panels from the upper portion of the rear housing cover by pushing them out toward the rear of the cover. (See Figure 2.)

(5) Insert the board into the rails (① in Figure 3) and slide it completely into the housing assembly.

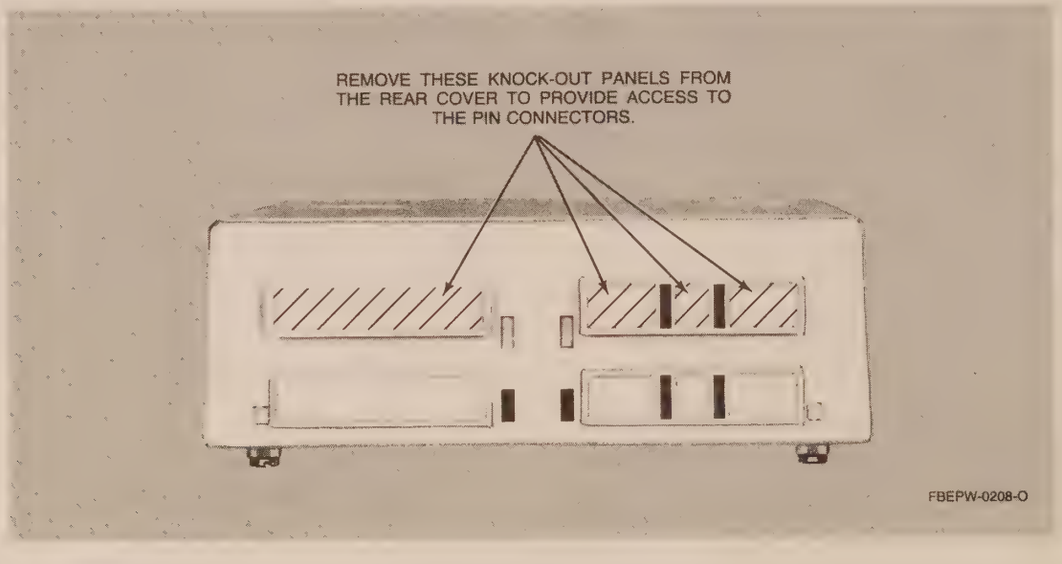



*Figure 2. Knockout Panels to be removed*

(6) Install the rear housing cover by inserting the tabs on the top of the cover into the holes in the top of the housing assembly (② in Figure 3), and swinging the cover down against the bottom and securing it with the two captive screws (③ in Figure 5).

(7) Use the contact removal tool to remove the following wires, with pins attached, from black connector P1101 (from the alternate control module):

- Yellow wire from Position 1
- Black-violet wire from Position 2
- Black-brown wire from Position 16
- Black-green wire from Position 20
- Shield from Position 10

(8) Free the end of the black-gray wire that is tied at the end of the cable.

**NOTE**

Skip Steps 9 and 10 when the wires extend at least five inches beyond the sleeving on the multiconductor cable.

(9) Remove the S hook from the end of the multiconductor cable and move the strain relief back about five inches from the ends of the wires.

(10) Cut and remove the cable sleeving to expose about five inches of the wires. Be careful not to cut the insulation of the wires. Hook the strain relief S hook to the bracket on the option housing.

(11) Insert the pins and wires you removed from P101 into dark blue connector P1 as follows:

- Yellow wire into Position 20
- Black-violet wire into Position 11
- Black-brown wire into Position 6
- Black-green wire into Position 4
- Shield into Position 22

(12) Insert the black-gray wire into Position 12 of dark blue connector P1.

(13) Certain pins and wires have been factory-installed in dark blue connector P1. Insert their free ends into P101 as follows:

- Yellow wire into Position 1
- Black-violet wire into Position 2
- Black-brown wire into Position 16
- Black-green wire into Position 20
- Violet-black wire into Position 10

**NOTE**

Steps 14 and 15 deal with the remaining black wire.

(14) If the radio has a microphone hangup box (*Private-Line* radios), move the black wire from Pin 19 of the black connector to Pin 18 of the dark blue connector. Insert the free end of the black wire from dark blue connector P1 into Position 19 of black connector P101.

(15) If the radio has no microphone hangup box (carrier squelch radios), tie or tape back the black wire from Position 17 of dark blue connector P1.

(16) Reconnect all connectors except those for the microphone (P101, P102, P104) to the alternate control module.

**NOTE**

Figure 4 shows the location of jacks for Steps 17 through 19.

(4) For radios with both *MVS-20* and *MDC-600* options, attach the red wire (with individual push-pin connector) to the TX switch 9.5V pin at P4 (adjacent to R1001) on the radio's main board. For radios with no *MDC-600* option, cut off the red wire at the strain relief.

(5) Remove R453 from the *Mitrek* main circuit board.

(6) Solder the orange wire to the hole formerly occupied by R453 that connects to Pin 1 of U403.

(7) Solder the violet wire to the other hole formerly occupied by R453.

(8) Attach the yellow wire (with jumper clip) to the radio interconnect board at Position JU3-B.

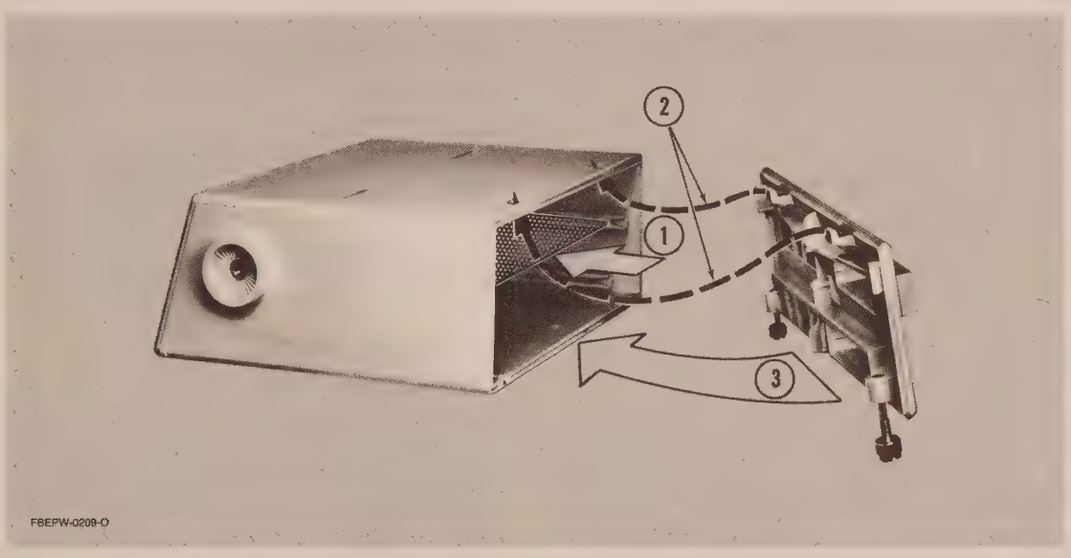



*Figure 3. Installation of Circuit Board and Rear Cover*

(17) Connect dark blue connector P1 to J1 on the back of the *MVS-20* circuit board.

(18) Install the short cable assembly with black connectors on both ends (HKN4045A) by connecting one end to J103 on the alternate control module and the other end to J2 of the *MVS-20* circuit board.

(19) Connect the microphone to J4 on the *MVS-20* circuit board.

1.3.2 Install the HLN4573A discriminator muting board as follows:

(1) Position the radio set with the top side up.

(2) Remove the top cover.

(3) If the radio has a *Private-Line* board or a time-out timer board, remove it.

**NOTE**

For low-band *Mitrek* radios with the extender option, remove the jumper clip from the yellow wire and solder the wire to the pad of JU15 (or L18 on early models) closest to the top of the radio interconnect board. The extender jumper clip should be in position JU3-C on the interconnect board ("Extender on" position). JU15 or L18 need not be removed.

(9) Mount the HLN4573A circuit board on a boss near the control cable connector. (See Figure 1.)

(10) Reinstall the *Private-Line* board or the time-out timer board (if removed) and the top cover.

1.3.3 For positive-ground installations, see the Positive-Ground Installation panel in *Mitrek Sys-*

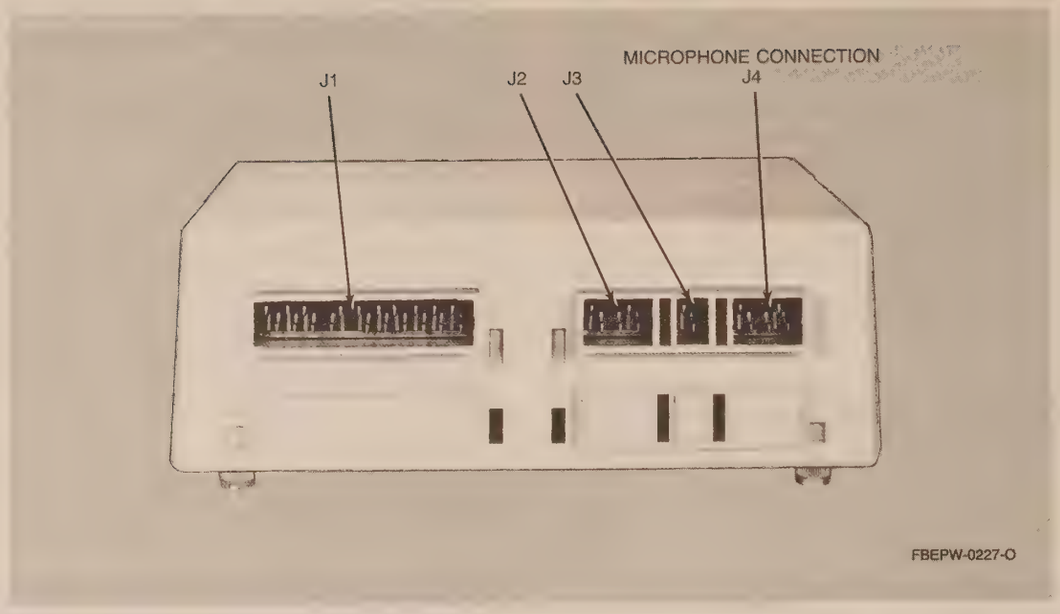



*Figure 4. Microphone Connection*

*tems 90* installation manual 68P81109E49 or 68P81110E50.

1.3.4 If the installation includes an *MDC-600* option, make no jumper cuts on the *MVS-20* circuit board. If you are installing *MVS-20* without *MDC-600,* cut JU3 and move JU1 to the JU2 position.

1.4 FACTORY-WIRED OPTION

1.4.1 When the radio is ordered with the *MVS-20* option, the factory makes the wiring changes and ships the individual system components with all interconnecting cables attached. This allows the system to be given a checkout before it is unpacked.

To install the radio system, proceed as follows:

(1) Install the radio and cabling as directed in the radio installation instructions.

(2) Install the trunnion bracket and housing assembly as instructed.

(3) Connect the black and blue connectors to the alternate control module.

**NOTE**

Figure 4 shows the locations of jacks referred to in Steps 4 through 6.

(4) Connect dark blue connector P1 to the *MVS-20* jack (J1).

(5) Install the short cable assembly with black connectors on both ends by connecting one end to J103 on the alternate control module and the other end to J2 on the *MVS-20* circuit board.

(6) Connect the microphone to J4 on the *MVS-20* circuit board. (See Figure 4.)

## 2. *SYNTOR*

2.1 GENERAL

The *MVS-20* system can be either a field-installed add-on or a factory-installed option, completely prewired. The *MVS-20* circuit board is installed in the *Systems 90•S* accessory housing, either alone or in combination with other *Systems 90•S* accessories. These installation instructions are for the *MVS-20* used as the only accessory. For multiple installations, refer to the installation instructions supplied with the housing assembly.

All UHF *SYNTOR* radios and all VHF *SYNTOR* AK model radios with HLD4018A or HLD4019A main board kits require the use of an HLD4018A or HLD4019A Interface Board with the *MVS-20*. All *SYNTOR* radios, except VHF models with BK suffixes, use the HKN4159A retrofit cable. Although BK models require neither the HLN4373A Interface Board nor the HKC4159A Retrofit Cable, when they are used with control cables in the HKN403−A series, they require limited modifications to the radios.

The HLN4373A interface board contains channel sense circuitry. Four color-coded wires connect it to various points on the radio's main board and the interconnect board.

The HKN4159A retrofit cable is a single wire between the interconnect board and the main board. It gives the *MVS-20* circuit board access to the radio detector mute control circuitry .

## 2.2 FIELD-INSTALLED ADD-ON

2.2.1 To install the *Systems 90•S MVS-20* circuit board in the field:

(1) Determine whether the *MVS-20* board will be on the upper or lower level of the housing assembly, and remove the corresponding row of knockouts from the rear housing cover (Figure 2). Remove the panel by pushing it out toward the rear of the cover. If possible, install *MVS-20* in the upper slot, where it is easy to operate.

(2) Put the circuit board between the rails as shown in Figure 3 and slide it all the way into the housing assembly. (Figure 3 shows the *Mitrek* control head, but the *SYNTOR* is similar.)

(3) Remove the old escutcheon, if there is one, from the front panel. Remove the *MVS-20* escutcheon from its backing and apply it carefully to the front panel of the housing assembly. Use care to align the holes in the escutcheon with the holes in the panel.

(4) Install the rear housing cover by inserting the tabs on the top of the cover into the holes in the top of the housing assembly (Figure 3) and swinging the cover down against the bottom and securing it with the two captive screws.

(5) Disconnect black connector P1011 from the control head.

(6) Use the contact removal tool to remove the following wires, with pins attached, from P1101:

- Yellow wire from Position 1
- Black-violet wire from Position 9
- Black-brown wire from Position 16
- Black-green wire from Position 20
- Shield from Position 21

**NOTE**

Skip Steps 7 and 8 if the wires extend at least five inches beyond the sleeving on the multiconductor cable.

(7) Remove the S hook from the end of the multiconductor cable and move the strain relief back about five inches from the ends of the wires.

(8) Cut and remove the cable sleeving to expose about five inches of the wires. Be careful not to cut the insulation of the wires. Hook the strain relief S hook to the bracket on the option housing.

(9) Insert the pins and wires removed from P1101 into dark blue connector P1 as follows:

- Yellow wire into Position 20
- Black-violet wire into Position 11
- Black-brown wire into Position 6
- Black-green wire into Position 4
- Shield into Position 22

(10) Certain pins and wires have been factory-installed in dark blue connector P1. Insert their free ends into P1101 as follows:

- Yellow wire into Position 1
- Black-violet wire into Position 9
- Black-brown wire into Position 16
- Black-green wire into Position 20
- Violet-black wire into Position 21

**NOTE**

Steps 18 and 19 deal with the remaining black wires.

(11) The white wire that connects J1-3 to J1-8 (dark blue connector) is a spare wire for channel sense on other *Systems 90•S* options. If such an option is used, remove the white wire from J1-3 and insert it into the appropriate position on that circuit board. (An example is the DATE INHIBIT line on *MDC-600* options.)

**NOTE**

Steps 12 and 13 are only for VHF *SYNTOR* radio models with BK suffixes and HKN40272A, 75A, 76A, 77A, and 96A control cables.

(12) Use the contact removal tool to remove the red-yellow wire from the yellow connector (P1105-5) and insert it into the dark blue connector (P1-19).

(13) Use the contact removal tool to remove the red-orange wire from the yellow connector (P1105-3) and insert it into the dark blue connector (P1-12).

**NOTE**

Steps 14 and 15 are for other radios that require the HLN4373A interface board or HKN4159A retrofit cable, and for VHF BK models with HKN403−A series control cables.

(14) Use the contact removal tool to remove the red-blue wire from the blue connector (P1102-17) and insert it into the dark blue connector (P1-19).

(15a) For UHF *SYNTOR* radios with HKN4072A, 75A, 76A, 77A, and 96A control cables, remove the red-orange wire from the yellow connector (P1105-3) and insert it into the dark blue connector (P1-12).

(15b) For all radios with HKN403_A series control cables (depending on what other *Systems 90•S* options are used), remove one of the following wires (if not already used) from its normal location and insert it into the dark blue connector (P1-12). Be sure to meet the requirements given in Table 1.

If no spare wire is available, use an HKN4072A, 75A, 76A, 77A, or 96A control cable instead.

**NOTE**

Radio models with AK suffixes use interconnect board HLN4109A. Radio models with BK suffixes use interconnect board HLN4357A.

**NOTE**

Figure 4 shows the jacks referred to in Steps 16 through 18.

(16) Reconnect P1102 to J1102 on the control head.

(17) Connect the microphone to J4 on the *MVS-20* board.

(18) Install the short cable assembly with the black connectors on both ends (HKN4045A) by inserting one end into J1103 on the control head and attaching the other end to J2 of the *MVS-20* circuit board.

(19) If the radio has a microphone hangup box (*Private-Line* radios), move the black wire from Pin 19 of black connector P1101 to Pin 18 of dark blue connector P1. Insert the free end of the black wire from the dark blue connector (P1-17) into Position 19 of black connector P1101.

(20) If the radio has no microphone hangup box (carrier squelch radios), tie or tape back the black wire from the dark blue connector (P1-17).

(21) Reconnect P1101 to J1101 on the control head.

(22) Connect P1 to J1 on the *MVS-20* board.

Installation of the *MVS-20* is now complete for VHF *SYNTOR* radios with BK suffixes and HKN4072A, 75A, 76A, 77A, or 96A control cables.

2.2.2 This section describes the procedure for installing the HLN4373A Interface Board and the HKN4159A Retrofit Cable.

VHF RADIO

(1) Position the radio set with the top side up.

(2) Remove the top cover.

*Table 1. Wires which may be used for detector mute* ***SYNTOR*** *radios*

| Wire Color | Normal Position In HKN403_A Series Control Cable | Designated Function | Additional Requirements If Wire Is Available |
|---|---|---|---|
| Violet | P1101-5 | MPL | (i) On the radio interconnect board, JU1 and JU3 must be out. (JU1 is on AK models only.)<br>(ii) Be sure that JU4/JU10 on the DPL/PL board is out. |
| White-Gray | P1102-5 | SIDETONE | (i) On AK models, JU1 and JU2 on the interconnect board must be out.<br>(ii) On BK models, main board components JU451, CR452, and CR453 must be removed. |
| Black-Gray | P1101-7 | DECIMAL SELECT TALKAROUND | For VHF models only, main board component R1190 must be removed if present. (R1190 is not used on early models with HLD4018A/4019A main board kits.) |
| Black-Blue | P1101-4 | PL ON/OFF | Interconnect board component R2 must be removed. |

(3) If the radio has a *Private-Line* circuit board or a time-out timer board, remove it.

(4) Unplug the black and the red wires from the radio's front connector (J6-A and J6-B) and remove the insulating paper behind the interconnect board.

**NOTE**

Steps 5 through 7 apply only to VHF AK models with HLD4018A/19A main board kits.

**NOTE**

If Q490 and Q491 are present (near the audio final output transformer), the main board kit is an HLD4018B/19B. If Q490 and Q491 are missing, it is an HLD4018A/19A.

5) Cut the plugs off the ends of the red wire and the black wire coming from the interface board. Remove one-eighth inch of insulation from the ends of the red and black wires.

(6) Solder the red wire to the plated-through hole (regulated 9.6 volts) near the front of the radio. The plated-through hole is at the end of a heavy runner on the component side, about midway between C1003 and E1015. (On earlier models with HLD4018A/4019A main board kits, it is about midway between C1003 and CR453.)

(7) Solder the black wire to the end of R928 that connects to B– (ground). R928 is adjacent to the power set potentiometer (R911).

**NOTE**

Steps 8 and 9 are for UHF models only.

(8) Install the red wire from the interface board on the push pin at E1004.

(9) Install the black wire from the interface board on the push pin at E1006. For models with RF preamplifier option, cut the lug off the end of the black wire and solder it to B– (ground) at the plated-through hole next to E1006.

**NOTE**

Steps 10 through 12 are for VHF AK models with HLD4018A/19A main board kits and for all UHF *SYNTOR* radios.

(10) Solder the orange wire to J6-26 on the interconnect board.

(11) Solder the yellow wire to J1-9 on the interconnect board.

(12) Screw the interface board to the radio chassis. (See Figure 5.)

**NOTE**

Step 13 is for VHF AK models with HLD4018B/19B main board kits and VHF BK models with HKN403_A series control cables.

(13) Solder a five-inch jumper between J1-9 and J6-26 on the interconnect board.

**NOTE**

Steps 14 and 15 are for VHF AK models and all UHF *SYNTOR* radios.

(14) Insert the push-pin of the HKN4159A retrofit cable (white-violet wire) into the terminal on P201 that connects to R235 and C236.

(15) Solder the other end of the white-violet wire to J1 on the interconnect board. The exact terminal to be used depends on which wire has been inserted into dark blue connector J1-12 on the *MVS-20* board (as determined in Step 14 of Section 2.2.1).

| Wire inserted into J1-12 in Step 15 of Section 2.2.1 | Terminal that the white-violet wire is to be soldered to |
|---|---|
| red-orange | J6-35 |
| violet | J6-27 |
| white-gray | J6-25 |
| black-gray | J6-12 |
| black-blue | J6-10 |

**NOTE**

Step 16 is for VHF BK models with HKN403_A series control cables.

(16) Solder a two-inch jumper between J6-35 and J6-27 or J6-25 or J6-12 or J6-10, depending on which wire has been inserted into dark blue connector J1-12 on the *MVS-20* board (Step 15 of Section 2.2.1).

| Wire inserted into J1-12 in Step 15 of Section 2.2.1 | Terminal that J6-35 is to be jumpered to |
|---|---|
| violet | J6-27 |
| white-gray | J6-25 |
| black-gray | J6-12 |
| black-blue | J6-10 |

(17) Put the insulating paper back in place and insert the black and red wires into the front connector (J6-A and J6-B).

(18) Reinstall the *Private-Line* board or the time-out timer board (if removed) and the top cover.

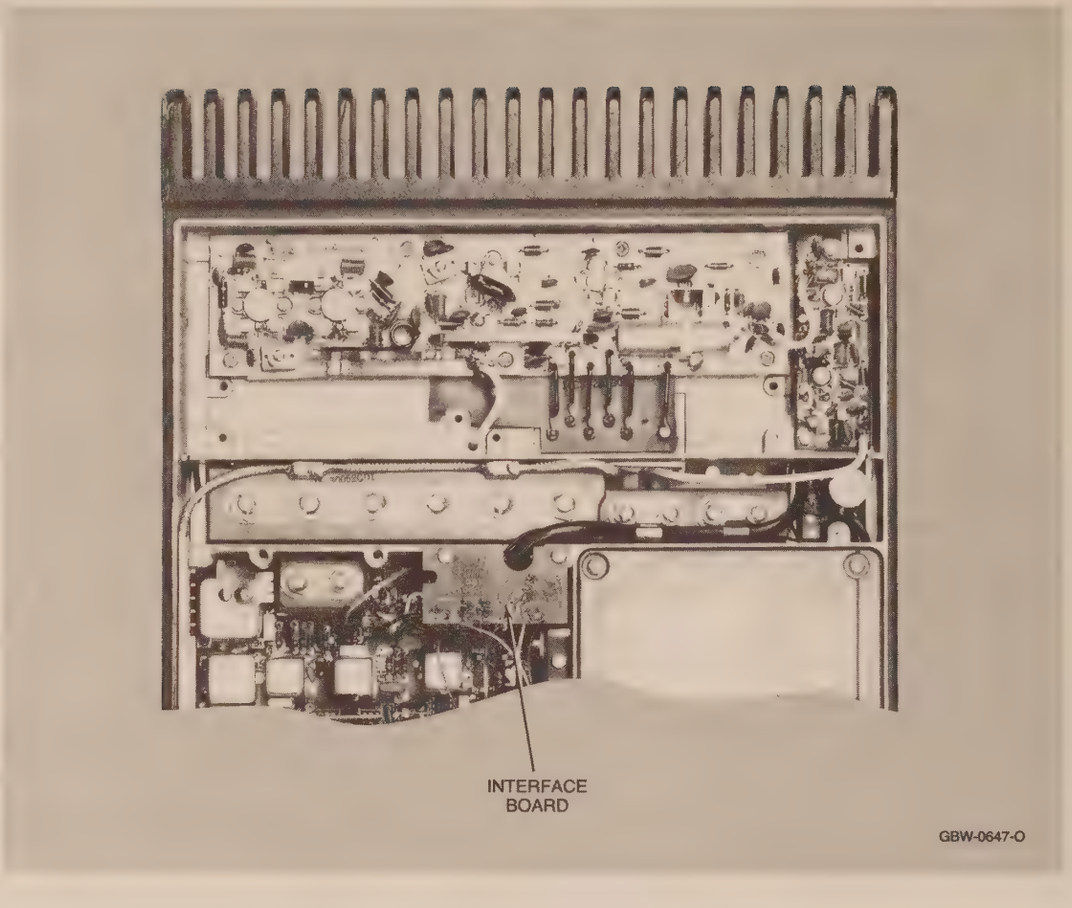



*Figure 5. Interface Board in UHF **SYNTOR** Radio*

2.2.3 The positive-ground installation panel in *SYNTOR Systems 90•S* installation manual 68P81110E62 explains the wiring differences for positive-ground systems.

2.2.4 If the installation includes an *MDC-600* option, make no jumper cuts on the *MVS-20* circuit board. If you are installing *MVS-20* without *MDC-600,* cut JU3 and move JU1 to the JU2 position.

2.3 FACTORY-WIRED OPTION

When *MVS-20* is ordered with the *SYNTOR* radio system, the factory makes the wiring changes and ships the individual system components with all interconnecting cables attached to permit the system to be checked thoroughly before it is unpacked. To install the radio system:

(1) Install the radio and cabling as directed in the radio installation instructions.

(2) Install the trunnion bracket and housing assembly as instructed.

(3) Connect the black (and blue, if used) connector to the control head.

**NOTE**

Figure 4 shows the locations of the jacks referred to in Steps 4 through 6.

(4) Connect dark blue connector P1 to the *MVS-20* jack (J1).

(5) Connect black connector P2 to J2 on the *MVS-20* board and black connector P1103 to J1103 (microphone connector) on the control head.

(6) Connect the microphone to J4 on the *MVS-20* board.

## 3. *SYNTOR X*

3.1 GENERAL

The *MVS-20* system can be either a field-installed add-on or a factory-installed option, completely prewired. The *MVS-20* circuit board is installed in the accessory housing, either alone or in combination with other radio accessories. These installation instructions cover the *MVS-20* used as the only accessory. For multiple installations, refer to the installation instructions supplied with the housing assembly.

The HLN4270B interface board contains circuitry that allows the radio's detector-mute circuit to be externally controlled. During playback of recorded messages, the detector mute control prevents discriminator noise from feeding through the radio and getting on the receive audio. The HLN4270B is factory installed in new radios, but must be added to earlier models in the field.

The HKN4160A adapter cable connects the detector mute control port (U251-5) on the HLN4239A or TRN8860A/B rf board to the mute control input on the HLN4270B interface board.

3.2 FIELD-INSTALLED ADD-ON

3.2.1 To install *MVS-20* in the field:

(1) Determine whether the *MVS-20* board will be on the upper or lower level of the housing assembly, and remove the corresponding row of knockouts from the rear housing cover (Figure 2). Remove the panel by pushing it out toward the rear of the cover. If possible, install the *MVS-20* board in the uppermost slot to make it easy to operate.

(2) Put the circuit board between the rails as shown in Figure 3 and slide it all the way into the housing assembly.

(3) Remove the escutcheon from its backing and apply it carefully to the front panel of the housing assembly. Use care to align the holes in the escutcheon with the holes in the panel.

(4) Install the rear housing cover by inserting the tabs on the top of the cover into the holes in the top of the housing assembly (Figure 3) and swinging the cover down against the bottom and securing it with the two captive screws.

(5) Disconnect black connector P1101 from the control head.

(6) Use the contact removal tool to remove the following wires, with pins attached, from P1101:

- Yellow wire from Position 1
- Black-violet wire from Position 9
- Black-brown wire from Position 16
- Black-green wire from Position 20
- Shield from Position 21

**NOTE**

Skip Steps 7 and 8 if the wires extend at least five inches beyond the sleeving on the multiconductor cable.

(7) Remove the S hook from the end of the multiconductor cable and move the strain relief back about five inches from the ends of the wires.

(8) Cut and remove the cable sleeving to expose about five inches of the wires. Be careful not to cut the insulation of the wires. Hook the strain relief S hook to the bracket on the option housing.

(9) Insert the pins and wires removed from P1101 into dark blue connector P1 as follows:

- Yellow wire into Position 20
- Black-violet wire into Position 11
- Black-brown wire into Position 6
- Black-green wire into Position 4
- Shield into Position 22

(10) Insert the free ends of the wires factory-installed in dark blue connector P1 into P1101 as follows:

- Yellow wire into Position 1
- Black-violet wire into Position 9
- Black-brown wire into Position 16
- Black-green wire into Position 20
- Violet-black wire into Position 21

**NOTE**

Steps 18 and 19 deal with the remaining black wire from the dark blue connector (P1-17).

(11) The white wire that connects between J1-3 and J1-8 (dark blue connector) is a spare wire for channel sense in other *Systems 90•S* options. If the radio has such an option, remove the white wire from J1-3 and insert it into the appropriate position on that circuit board. (An example is the DATA INHIBIT line on *MDC-600* options.)

**NOTE**

The following two steps are for *SYNTOR X* radios with HKN410_A series control cables only.

(12) Use the contact removal tool to remove the red-orange wire from the yellow connector (P1105-3) and insert it into the dark blue connector (P1-19).

(13) Use the contact removal tool to remove the red-brown wire from the yellow connector (P1105-6) and insert it into the dark blue connector (P1-12).

**NOTE**

The following two steps are only for *SYNTOR X* radios with HKN409_A

series control cables and without channel scan options.

(14) Use the contact removal tool to remove the black-gray wire from the black connector (P1101-7) and insert it into the dark blue connector (P1-19).

(15a) Use the contact removal tool to remove the red-blue wire from the blue connector (P1102-17) and insert it into the dark blue connector (P1-12).

(15b) Remove the radio top cover and solder a one-inch jumper wire between Pin 7 and Pin 34 of J1 on the solder side of the personality board (HLN4257/TRN8861).

(15c) Remove jumper JU300 from the HLN4270B interface board.

**NOTE**

The following two steps are for *SYNTOR X* radios with TKN808_A series control cables.

(16a) Use the contact removal tool to remove the red-blue wire from the blue connector (P1102-17) and insert it into the dark blue connector (P1-12).

(16b) Remove the top cover and solder a one-inch jumper wire between Pin 7 and Pin 34 of J1 on the solder side of the personality board (HLN4257/TRN8861).

(16c) Remove jumper JU300 from the HLN4270B interface board.

(17) Depending on what other *Systems 90•S* options are used, remove one of the wires from its normal position and insert it into the dark blue connector (P1-19). Be sure to meet the requirements given in Table 2.

(18) If the radio has a microphone hangup box (*Private-Line* radios), move the black wire from Pin 2 of black connector P1101 to Pin 18 of dark blue connector P1. Insert the free end of the black wire from the dark blue connector (P1-17) into Position 2 of black connector P1101.

(19) If the radio has no microphone hangup box (carrier squelch radios), tie or tape back the black wire from the dark blue connector (P1-17).

(20) Reconnect P1101 and P1102 to J1101 and J1102 on the control head.

(21) Connect P1 to J1 on the *MVS-20* board.

(22) Connect the microphone to J4 on the *MVS-20* board.

3.2.2 Install the HKN4160A adapter cable as follows:

(1) Position the radio set with the bottom side up.

(2) Remove the mounting plate (if attached) and the bottom cover.

(3) Loosen the three mounting screws with plastic inserts and turn the common circuits board on its hinges. (See Figure 6.)

(4) Remove rf board component R260 (between U251 and Q250). (See Figure 7.)

(5) Slip the free end of the HKN4160A adapter cable through the gap between the two cable connectors on the common circuit board and then solder it to U251-5 at the hole formerly occupied by R260.

(6) Insert the three-pin connector of the HKN4160A adapter cable into J301 on the HLN4270B interface board.

(7) Reinstall the common circuits board.

(8) Reinstall the bottom cover and the mounting plate.

*Table 2. Wires which may be used for Channel Sense in* ***SYNTOR X*** *radios*

| Wire Color | Normal Position In Control Cable | Designated Function | Additional Requirements If Wire Is Available |
|---|---|---|---|
| Violet | P1101-5 | Control Head Strobe | (i) Remove personality board components Q1 and R1, and<br>(ii) Solder jumper wire between Pin 1 and Pin 6 of J1 on personality board. |
| Black-Gray | P1101-7 | Display Enable | Disasemble control cable P1 housing and move black-gray wire from Position 33 to Position 6. |
| Black-Blue | P1101-4 | PL/DPL Disable | Disassemble control cable PL housing and move black-blue wire from Position 32 to Position 6. |
| White-Gray | P1102-5 | Channel Scan Enable | Disassemble control cable PL housing and move white-gray wire from Position 31 to Position 6. |

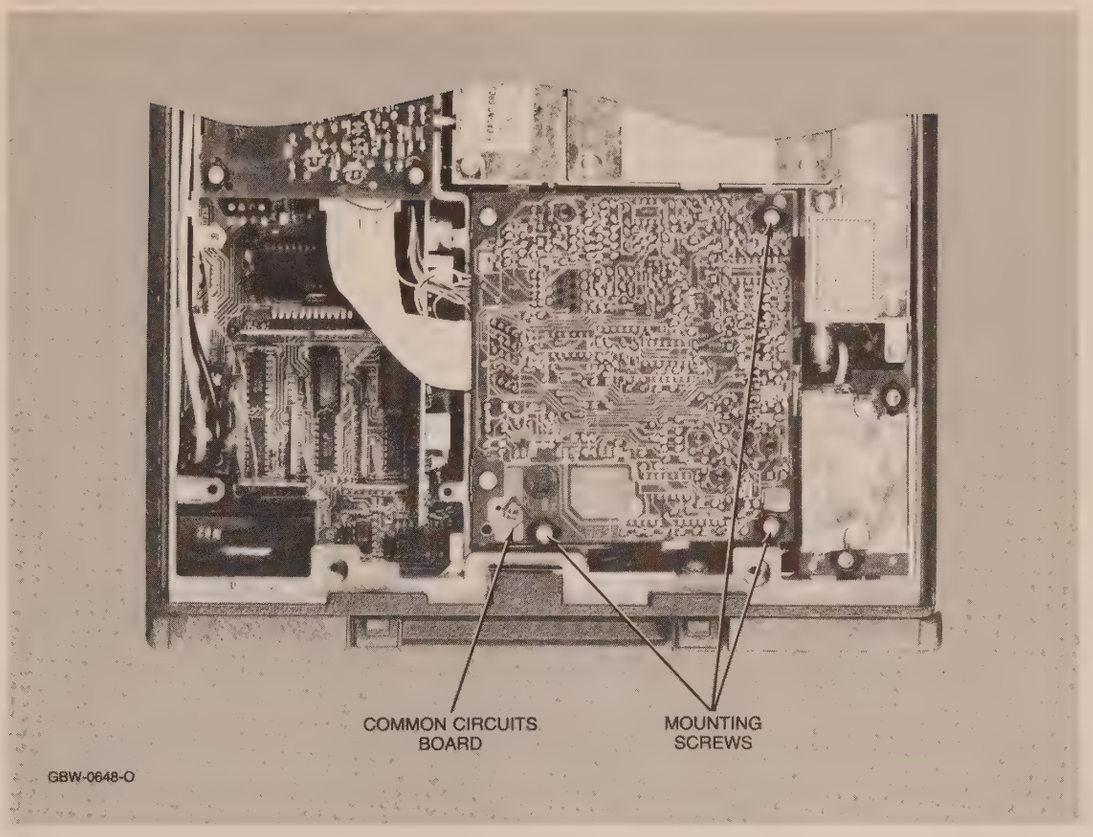



*Figure 6. 800-MHz **SYNTOR X** Radio*

3.2.3 Install the HLN4270B interface board as shown in the *SYNTOR X* radio manual.

**NOTE**

If the radio has an HLN4270A interface board, replace it with the HLN4270B interface board. The HLN4270A interface board is *not* compatible with *MVS-20*.

**NOTE**

If you inserted the red-blue wire into the dark blue connector (P1-12), be sure to remove JU300 from the HLN4270B interface board.

**NOTE**

J101 was not installed in earlier models. If it is missing, cut the push-pin connector off the red-brown wire (W308) and solder it to the plated-through hole where the J101 center pin connects to the personality board. This hole is between the cable connector (J1) and the resistor network (HY1). It is connected to J1-7 via a component-side runner on the HLN4257/TRN8861 personality board.

3.2.4 For positive-ground installations, refer to the Positive-Ground Installations panel on *SYNTOR X Systems 90•S* Installation Sheet 68P81110E93.

3.2.5 If the installation includes an *MDC-600* option, make no jumper cuts on the *MVS-20* circuit board. If you are installing *MVS-20* without *MDC-600,* cut JU3 and move JU1 to the JU2 position.

3.3 FACTORY-WIRED OPTION

When *MVS-20* is ordered with the *SYNTOR X* system, the factory makes the wiring changes and ships the individual system components with all interconnecting cables attached to permit the system to be checked thoroughly before it is unpacked. To install the radio system:

(1) Install the radio and cabling as directed in the radio installation instructions.

(2) Install the trunnion bracket and housing assembly as instructed.

(3) Connect the black (and blue, if used) connector to the control head.

**NOTE**

Figure 4 shows the location of jacks referred to in Steps 4 through 6.

(4) Connect dark blue connector P1 to *MVS-20* jack J1.

(5) Install the short cable assembly with black connectors on both ends (HKN4045A) by inserting one

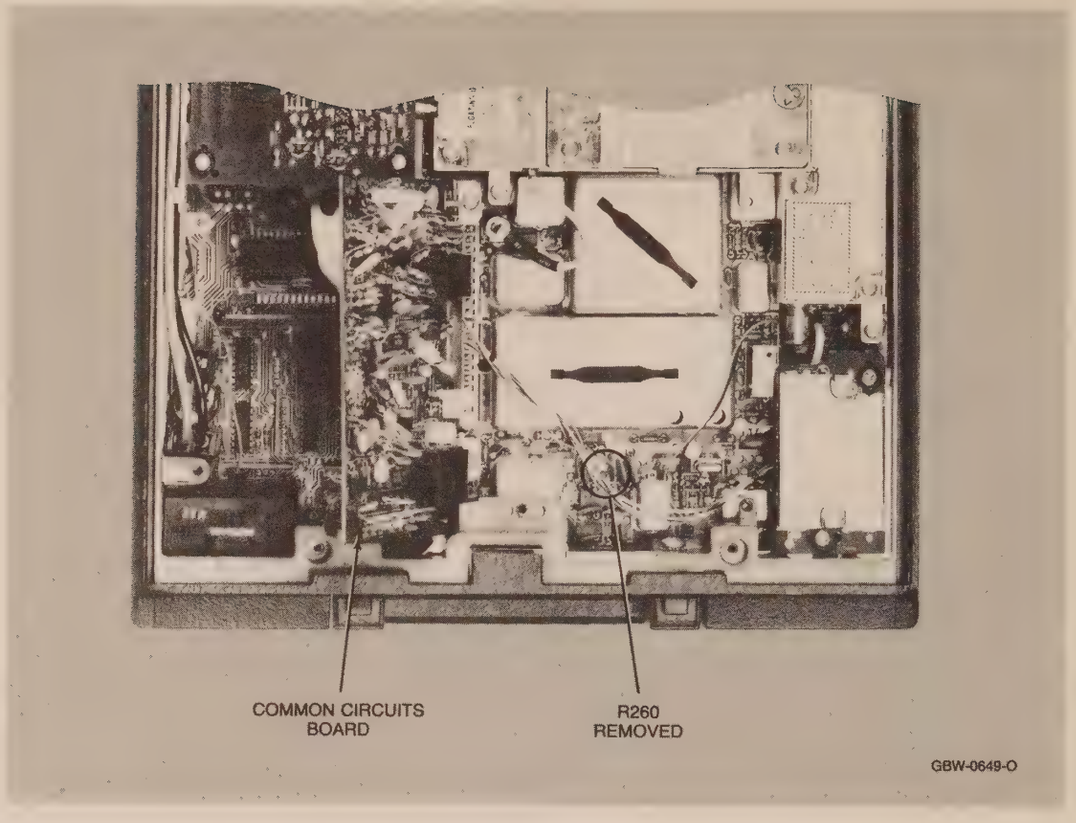



*Figure 7. 800-MHz **SYNTOR X** Radio with Common Circuits Boards Hinged Out*

end into J1103 on the control head and the other end into J2 of the *MVS-20* circuit board.

(6) Connect the microphone to J4 on the *MVS-20* board.

# THEORY OF OPERATION

## 1. Code Plug

The code plug (U9) for *MVS-20* is a read-only memory (ROM) that contains information needed by the microcomputer. Part of this information is preset at the factory and affects the basic functions of the *MVS-20*. The rest of it is personalized information, such as unit, group, and fleet numbers. It is read into the microcomputer when the *MVS-20* is first turned on.

Pins 10, 11, 12, and 13 of the code plug receive the address from Pins 22, 23, 24, and 25. (Three of these lines also send address inputs to U10, but not while the code plug is being read.) The code plug data output is from Pins 1, 2, and 3. (The three lines are also address inputs for U11, U12, U13, and RAM U14, but are not used while the code plug is being read.) To prevent interference when the RAM is being addressed, the code plug power is turned off when it is not being read. This also reduces current drain.

Q24, R77, and R78 turn the code plug on and off. When the *MVS-20* is turned on, Q24 is turned on. The collector of Q24 is tied to Pin 16 of U9, and the emitter to +5V. Power goes to U9 through Q24, Pin 16 of U9 ($V_{cc}$), and Pin 8 of U9 (ground). Current through R78, between +5V and the base of Q24, biases the base to +5V and turns off Q24. The μC (U5) internally grounds its own Pin 29. Through the current-limiting resistor (R77), this pulls the +5V of the Q24 base to approximately +4.3V and turns on Q24 and U9.

## 2. Power Supply

The *MVS-20* has three operating voltages: B+ at +13.8V ±20%; +9.4V; and +5V. For the lower voltages, B+ is regulated down to +9.4V, which is in turn regulated down to +5V.

### 2.1 B+ (+13.8V ±20%)

B+ goes to Pins 9 and 20 of J1, with ground reference at Pins 10 and 11. The voltage at Pins 9 and 20 should be +13.8V ±20%.

Diode CR5 (in conjunction with the in-line fuse) protects against reverse polarity. If power is connected with the wrong polarity, the diode conducts and blows the fuse. C31 filters the B+ line and reduces electrical noise.

### 2.2 +9.4V

Q20, a pass device, drops B+, supplied to its collector, to 9.4V, supplied at its emitter. Q20 is biased on by R67. VR1 holds the bias voltage at about +10V in order to maintain the voltage at the emitter of Q20 close to +9.4V. C32 and C33 filter electrical noise from the supply and the load.

### 2.3 +5V

U4, a +5V regulator IC, regulates 9.4V to +5V. C34 filters the +5V supply.

## 3. Microphone PTT Circuits

The PTT line must be brought low (high in positive-ground systems) to make the radio transmit. Either the microphone or the microcomputer can make this happen.

Keying the microphone connects Pin 3 of J4, which is grounded, to Pin 6 of J4 to bring it low. Pin 6 of J4 is the input to an inverter, so the inverter produces a high when the microphone is keyed.

The inverter is made up of R1, R2, R3, and Q1. R1 and R2 bias Q1 in the on state, grounding the collector of Q1, to produce a low output. When Pin 6 of J4 is grounded, the voltage across R2 is zero, as is the bias current. Q1 turns off and R3 pulls the output high. The inverter output fans out to three inputs.

3.1 When the inverter output is high, it goes through R5 to bias Q3 on and ground the detected audio input to the record filter. This muting circuit prevents noise from the radio receiver from being mixed with the mobile operator's message during recording.

3.2 The inverter output lets the microcomputer know when the microphone is keyed through Pin 34 of U5 (PTT sense).

3.3 The microphone PTT circuit (R4, CR2, and Q2) has two modes that depend on the position of S3. When S3 is in the TX position, the emitter of Q2 is grounded so that a high from the inverter (through R4 and CR1) biases Q2 on and pulls its collector low. With JU1 in and JU2 out, this pulls the PTT line low and the radio transmits. If S3 is

in the record mode, the Q2 emitter is open and the PTT circuit is disabled.

### 4. Microcomputer PTT Circuits

The microcomputer makes the radio transmit, disables audio from the microphone, and enables audio from the *MVS-20* D-to-A converter (so that signaling and recorded messages can be transmitted) by producing a low at Pin 27. Pin 19 of J1 (channel busy) is low when the microcomputer is transmitting and indicates to other options that they should inhibit their transmissions.

Normally Pin 27 of U5 is high and biases Q4 on through R6. Q4 completes the connection from MIC LO of the microphone to MIC LO of the control head and allows audio from the microphone to be transmitted. When Pin 27 is low, Q4 turns off and causes an open in the MIC LO line that disables audio from the microphone. Pin 27 is also connected to the input of an inverter that is formed by R7, R8, and Q5.

4.1 A high from Pin 27 biases Q5 on through R7 and produces a low at the Q5 collector. A low from Pin 27 turns Q5 off by removing the bias current and allows R8 to pull its collector high. The output of this inverter fans out to three circuits.

4.1.1 The first of these is the channel-busy circuit, which is discussed in the Channel-Busy Section.

4.1.2 The second is the microcomputer PTT circuit, consisting of Q8 and R12. A high from the inverter biases Q8 on through R12, pulls the PTT line low through JU1, and makes the radio transmit. The microcomputer transmit delay circuit (Q10, R13, C2, and CR2) grounds the base of Q8 for a fraction of a second on power-up to eliminate any chance of a transmission.

4.1.3 The third is an audio coupling circuit. A high from the inverter biases Q6 on through R9. Q6 then grounds the emitter of Q7, which, with R10, R11, and C1, makes up an audio coupling circuit. This circuit audio-couples data signaling and playback messages to be transmitted to the MIC HI line (as described in the Record/Playback Section).

### 5. Positive-Ground PTT Circuit

The circuit composed of JU1, JU2, R14, R15, and Q9 tailors the PTT circuits to negative-ground or positive-ground systems. For a negative-ground system, JU1 is in, allowing Q2 or Q8 to pull the PTT line low; JU2 is out, disabling R14, R15, and Q9. For a positive-ground system, JU1 is out and JU2 is in. When Q2 or Q8 turns on, it biases Q9 on through R14 and pulls the PTT line high. R15 normally pulls the base of Q9 to B+ and turns off Q9. A positive-ground system also requires changes to be made to the cable.

### 6. Channel-Busy Circuits

The channel-busy circuit senses when the channel is in use, and inhibits other options from transmitting when *MVS-20* is using the channel.

6.1 The channel-busy line connects to Pin 19 of J1. This connects in turn to the input of one inverter buffer (R18, Q12, and a pull-up resistor inside U5) and to the output of another (R16, R17, and Q11). The channel-busy line is normally high and biases Q12 on through R18. If the channel is busy (signal being received or another option transmitting), the line is pulled low, Q12 turns off, and the collector of Q2 and Pin 35 of U5 go high. If the send button is pressed with a message recorded, the microcomputer sends data to the base only after Pin 35 goes high (indicating that the channel is not busy).

6.2 If the microcomputer is sending data or initiating any transmission, R8 pulls the collector of Q5 high (as described in the Microcomputer PTT Circuits Section). This high (through R16) biases Q11 and grounds the channel-busy line. With Q11 off, R17 and pull-up resistors in other options that use the channel- busy line pull the channel-busy line high.

### 7. Hangup Box (HUB) Override Circuit

Only radios equipped with microphone hangup boxes use this circuit. The collector of Q13 connects to Pin 18 of J1 and the emitter to Pin 17. The cable kit wires these pins in series with the switch in the hangup box. When Q13 is off, the radio unmutes as if the microphone had been removed from the hangup box. The microcomputer operates Q13 via Pin 26. A high from Pin 26 biases Q13 through R23 and completes the HUB circuit. If Pin 26 is low, Q13 is off, the HUB circuit is open, and the speaker remains unmuted.

### 8. Volume Mute Switch

The volume mute switch consists of R24, R25, and Q14. It mutes by grounding the audio line from the wiper of the volume potentiometer to audio-in of the radio. This mutes audio to the speaker but does not affect audio from detected audio. The *MVS-20* and other options can continue to use the detected

audio line. Volume mute mutes the speaker so that the operator need not listen to a burst of PSK data signaling.

Pin 1 of J1 connects to the wiper of the volume potentiometer and Pin 4 of J1 to audio in the radio. Pin 31 of U5 is low when no muting is needed and goes high to mute volume. A high at Pin 31 pulls up the base of Q14 through R24 and biases Q14 on. Q14 then grounds Pin 4 of J1 and mutes audio to the radio. R25, in series with the audio line, improves the muting of Q14.

**9. Control Switches**

Four switches control the operation of *MVS-20*: Play (S1), Replay (S2), Record/Transmit (S3), and Send (S4).

9.1 PLAY

The PLAY button (S1) is a momentary switch. The mobile operator pushes it in to play back messages the *MVS-20* has recorded. This grounds Pin 18 of U5—a pin that an internal pull-up resistor normally holds high.

9.2 REPLAY

The REPLAY button (S2) also is a momentary switch. When the operator pushes it, he hears a replay of the last message played. If a new message has been entered since the last playback, he hears the new message. This switch grounds the normally high Pin 17 of U5.

9.3 RECORD/TRANSMIT

The record/transmit button (S3), labeled RECORD on the control head, is a push-in/push-release switch. In the transmit position (button out), it channels audio from the microphone to the radio transmitter and grounds the emitter of Q2, enabling the microphone PTT circuit. When the operator keys the microphone, the radio transmits as it normally would. In the record position (button in), the switch channels microphone audio to the input of the record filter. It also opens the emitter of Q2 to disable the microphone PTT circuit. In this position, the switch also grounds Pin 6 of the microcomputer to put it into the record mode. Keying the microphone initiates recording.

9.4 SEND

The SEND button (S4) is a momentary switch. When the operator pushes it in, it grounds the normally high Pin 19 of U5 and instructs the microcomputer to send. The microcomputer sends out data only if a message (recorded from the mobile) is in memory when the button is pushed.

**10. Lamp Circuit**

There is a lamp for each of the four buttons on the *MVS-20* mobile control head. The lamps glow dimly to illuminate the button labels in low light. The PLAY lamp (DS1) also glows brightly to show the mobile operator that the unit has recorded a message from the base.

B+ is applied to JU8 (normally in) and Pin 1 of J3. For the lamps to glow dimly, the power is applied at Pin 2 of J3 through JU8. (JU8 and the J3 connections allow for the use of an external switch to turn off the backlight and reduce current drain.) When B+ is applied to the lamp circuit, current flows through current-limiting resistors R72, R73, and R76, through lamps DS2, DS3, and DS4, and to ground, making the lamps glow dimly. In a similar manner, current flows through CR6, through current-limiting resistors R74 and R75, and through DS1 to ground to make DS1 glow dimly.

Pin 33 of U5 goes low if the unit has recorded a message from the base that the mobile operator has not reviewed. The low goes to gate D of U6. With Pin 11 of U6 grounded, Pin 12 is the only input and the output (Pin 13) is inverted. The high at Pin 13 goes through R69 to bias Q25 on. This goes through R70 to pull the base of Q26 down from B+ to 0.7V below B+ and biases Q26 on. (R71 normally holds the base of Q26 at B+ .) With Q26 on, current flows through Q26, through current-limiting resistor R75, through DS1, and to ground, making DS1 glow. DS1 now glows brighter than the other lamps because R75 has less resistance than R74, R71, R73, or R76. CR6 prevents the current from flowing to the other lamps if anyone removes JU8 without shorting Pins 1 and 2 of J3.

**11. Detected Audio In/Out**

Detected audio enters the *MVS-20* at Pin 6 of J1. Audio-low is the reference (Pins 21 and 22 of J1) which is being tied to the *MVS-20* ground. VR2, a 13V diode, bridges from detected audio to ground to protect *MVS-20* circuits from any static discharge to that pin. Detected audio goes through R43 to improve muting and on to several other circuits.

Detected audio goes to one of the three analog switches in U3 at Pin 13. When U3 switches to connect Pin 13 to Pin 14, detected audio goes through the dc blocking capacitor (C29) and to Pin 7 of J1 (detected audio out). VR4 protects Pin 7 of J1

from static discharge just as VR2 protects Pin 6.

Detected audio also goes to JU5 and R44, which form a level-adjusting circuit. This is needed because the level of detected audio out is different for different radios. *Mitrek* and *SYNTOR X* radios have nominal audio levels of 640mV rms and 600mV rms, respectively. *SYNTOR*'s is 250mV rms. With JU5 shorting across R44, the circuit is set for *SYNTOR*. If JU5 is removed, R44 reduces the audio level to the circuits that follow and compensates for the high levels of *Mitrek* and *SYNTOR X*. The output of this level-adjusting circuit goes to the PSK filter and the record filter.

If the microcomputer resets the analog switch to connect Pin 14 of U3 to Pin 12, it leaves Pin 13 open, turning on Q17 to ground and mute the detected audio. The details of this muting and switching operation are described in the Detected Audio Muting Section.

### 12. Detected Audio Muting

To mute detected audio, the *MVS-20* grounds the detected audio line. At the same time, it activates a circuit in the radio that reduces the gain of the last detected audio stage. Analog switch U3 connects its Pin 14 to Pin 12 instead of Pin 13 for playback messages.

The microcomputer outputs a high at Pin 30 to mute the detected audio. This high (through R19) biases Q17 and shorts the detected audio line to ground. This high also (through R20) biases on Q18 and brings low Pin 11 of U3. When Pin 11 is low, U3 switches the internal connection of Pin 14 from Pin 13 over to Pin 12. R22 and R21 pull up Pin 11 when Q18 is off. R22 also biases Q19 off when Q18 is off. When Q18 is on, Q19 is turned on to supply 9.4V at Pin 12 of J1. Pin 12 of J1 supplies voltage to a detected-audio-degaining circuit inside the radio. Diode VR3 protects the *MVS-20* from static discharges at Pin 12 of J1 and C30 filters out any rf on the line that could degrade circuit performance.

### 13. PSK (Phase-Shift Keying)

PSK signals on the detected audio go through a level-adjusting circuit (JU5 and R44) to the PSK filter.

The PSK filter, an active bandpass filter centered around 1.5 kHz, consists of one of four op amps in U1, plus C3, C4, C5, R46, and R47.

The output of this filter (Pin 7 of U1) goes to the PSK limiter, formed by R48, R49, C6, and one of two op amps in U2. A sinewave input to the limiter results in a squarewave output with a duty cycle very close to 50%. CR3 protects the microcomputer port from the output at Pin 7 of U2, because this output can go several volts over the power supply voltage of the microcomputer.

In sending PSK signaling, the microcomputer controls the D-to-A converter to form the signal that is then coupled to the MIC HI line.

Pins 4 and 5 of the microcomputer each drive an inverter buffer and the D-to-A converter. Pin 4 drives the inverter buffer made up of Q16 and R32. The inverter output controls the analog switch (Z of U3) through Pin 9 of U3. In the same manner, Pin 5 of the microcomputer drives the inverter buffer made up of Q15 and R26 to control analog switch Y at Pin 10 of U3.

The D-to-A converter consists of two of the three U3 analog switches, plus R33, R34, R35, R31, R27, R28, R29, R30, R87, C21, and C20.

The Z analog switch determines the direction of the slope of the output analog signal and the Y switch determines the degree of the slope. The result is an analog signal at R33 and C21 created from a digital input to Pins 9 and 10 of U3.

To create PSK, the microcomputer holds the slope intensity at its highest level and switches the slope direction with analog switch Z.

The analog signal goes to several circuits, but the one of concern for PSK is the audio coupling circuit that puts this audio on the MIC HI line to be transmitted. This circuit is made up of C1, R10, R11, and Q7. The MIC HI line is biased high internally to each of the radios, and R11 joins the MIC HI line to the base of Q7 to bias Q7 in the active region. C1 serves as a dc blocking capacitor. Q6 must be on to enable this circuit (as described in the Microcomputer PTT Circuit Section). The circuit is enabled when the microcomputer initiates a transmission. R10 sets the gain (or degree of coupling) to the MIC HI line and sets the deviation of the PSK signaling.

### 14. Recording

The *MVS-20* can record from two sources—the microphone and the detected audio.

For the *MVS-20* to record from the microphone, S3 must be in the record position (RECORD button

pushed in). This connects the microphone audio to one of the inputs of the record filter. R53 supplies to the microphone the dc bias current that normally comes from the MIC HI line. C9 and R54 are part of the filter circuit. When the system is recording from the microphone, Q3 is turned on and grounds and mutes audio from the detected audio input.

The detected audio input starts at R50, which with C7 forms a low-pass filter. R51 supplies a dc bias for the collector Q3, the mute switch. R52 and C8 are part of the active filter circuit.

The active filter is a bandpass filter divided into two stages. The output of the first stage is Pin 8 of U1 and the output of the second is at Test Point 7. These operate together to remove the low PL frequencies and the high receiver noise frequencies that interfere with the quality of the recording.

The filter output goes to a comparator that compares the signal coming in to be recorded with the output of the D-to-A converter (discussed in the PSK Section). The output of the comparator goes through a limiter circuit (part of an op amp in U2), which insures that it has a valid logic level. Then it goes to Pin 3 of the microcomputer. The microcomputer samples the comparator output at a rate of 12 kHz.

Each time the μC samples at Pin 3, it makes certain that switch Z is in the proper position to make the D to A output move closer to the same level as the audio being recorded. Upon sensing three requested bits of the same polarity at Pin 3, the microcomputer sets Pin 5 low. With Pin 5 of U5 low, Q15 turns off so that R26 can supply 9.4 V to Pin 10 of U3. This sets swtich Y of U3 to provide the larger step size. The step size switches low again when a sample shows that the level of the D-to-A output is up greater than that of the recorder.

This periodic sampling and changing allows the output from the D-to-A converter to track the recorder input waveform with good fidelity. Each time a sample is taken, the output of the comparator is recorded in RAM (U11, U12, U13, or U14), becoming a record of the serial bit string. This record can be used to reproduce the audio.

## 15. Playback

The microcomputer uses only one input (Pin 3) when the system is recording an audio signal. By checking this pin at a rate of 12 kHz, the microcomputer controls the D-to-A converter to put out a signal similar to the input signal.

The microcomputer also uses only one input (Pin 33) in playing back the signal, and this too is sampled at 12 kHz. The results of the samples taken during the recording are presented to Pin 33, and the microcomputer uses the D-to-A converter to recreate the signal just as it traced the incoming signal during recording.

The output of the D-to-A converter (Test Point 5) goes to a two-stage active bandpass filter. JU7 and R41 adjust the level of the filter output to match the detected audio. (JU7 is in for *Mitrek* and *SYNTOR X* and is out for *SYNTOR*). In the playback mode, analog switch X connects Pin 14 of U3 with Pin 12 and allows the playback signal to be played through the audio finals of the radio.

## 16. Random-Access Memories

Four RAM's store the digitized audio (see the Record/Playback Section), and each can store over 64,000 bits of digital information (about five seconds of audio). They are used one at a time, starting with U14.

Pin 28 of the microcomputer controls Pin 3 of the RAM to set the RAM in the read or write mode for recording or playback. The RAM records (or stores) the logic state of its Pin 2 during recording, and the microcomputer reads the RAM from RAM Pin 14. The RAM's are addressed at their Pins 5, 6, 7, 9, 10, 11, 12, and 13. An inverted pulse on the CAS (Column Address Strobe) line to Pin 15 indicates to the RAM that the address that is presented to it is a column address. An inverted pulse on the RAS (Row Address Strobe) signals the RAM that the address present is a row address.

Refresh (REF) works for all the RAM's. It uses an inverted pulse to activate internal auto-refresh circuitry.

## 17. $\overline{\text{RAS}}$, $\overline{\text{CAS}}$, and $\overline{\text{REF}}$

The $\overline{\text{RAS}}$, $\overline{\text{CAS}}$, and $\overline{\text{REF}}$ each have tolerances on when a pulse can start with respect to other pulses (including the address to the RAM) and the duration of the pulses. This function is performed by U6, U7, and U8.

## 18. Clock Buffer

Crystal Y1 holds the *MVS-20* clock to 4 MHz. One side of Y1 goes to an inverter buffer consisting of C38, R79, R80, and Q23. C38 blocks dc and low frequencies and passes 4 MHz. R79 biases Q23 in the active region. R80 sends power to the circuits. The $\overline{\text{CAS}}$, $\overline{\text{RAS}}$, and $\overline{\text{REF}}$ circuits use the output to create the pulses mentioned in the previous section.

# MAINTENANCE

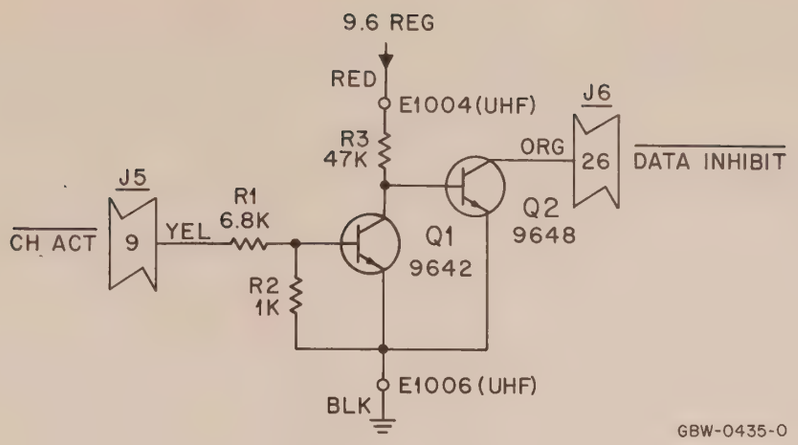
## 1. General

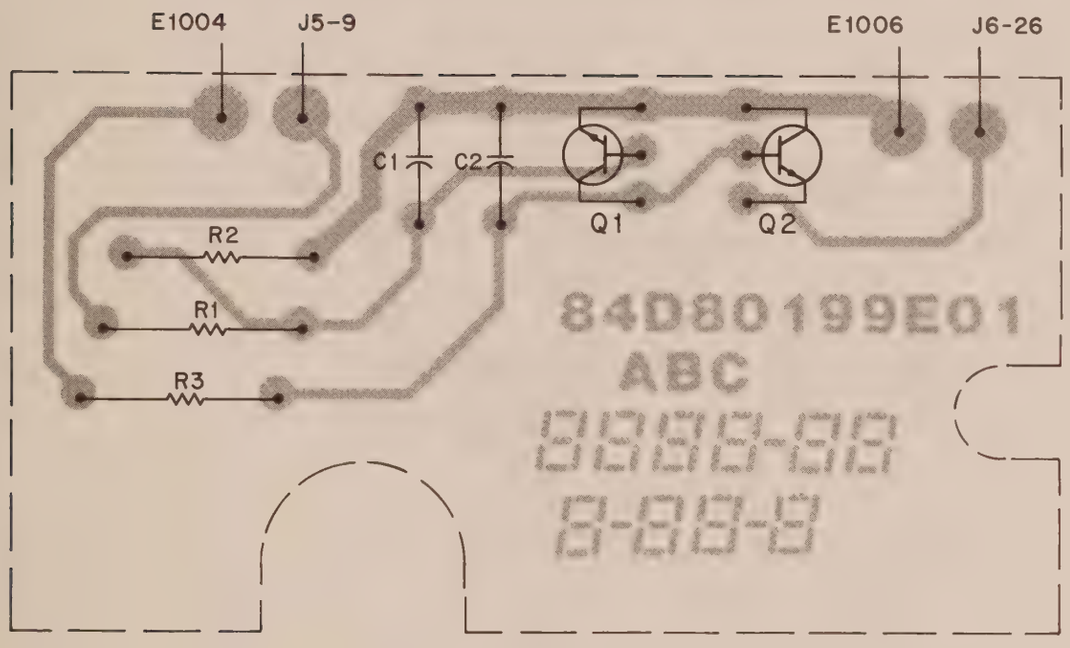
To test the circuit board of the mobile unit, connect it to a working radio set with the standard cable.

## 2. Troubleshooting Flow Chart

Use the troubleshooting flow chart on the following pages to isolate any malfunctions attributed to the *MVS-20* board. The chart's logical sequence of steps isolates the problem to a faulty component or circuit.

| General Type | Recommended Model |
|---|---|
| DC Multimeter | R1024 or equivalent |
| Oscilloscope | R1004 or equivalent |




CIRCUIT BOARD
GCW-0439-O

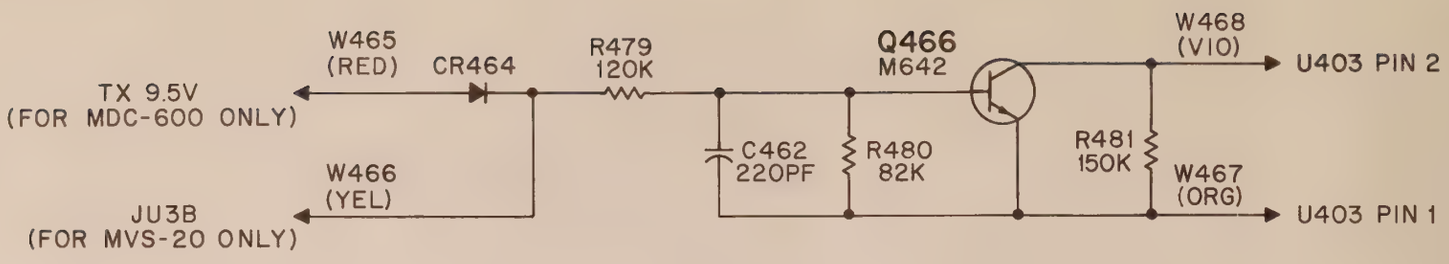
OVERLAY
GCW-0440-O

# parts list

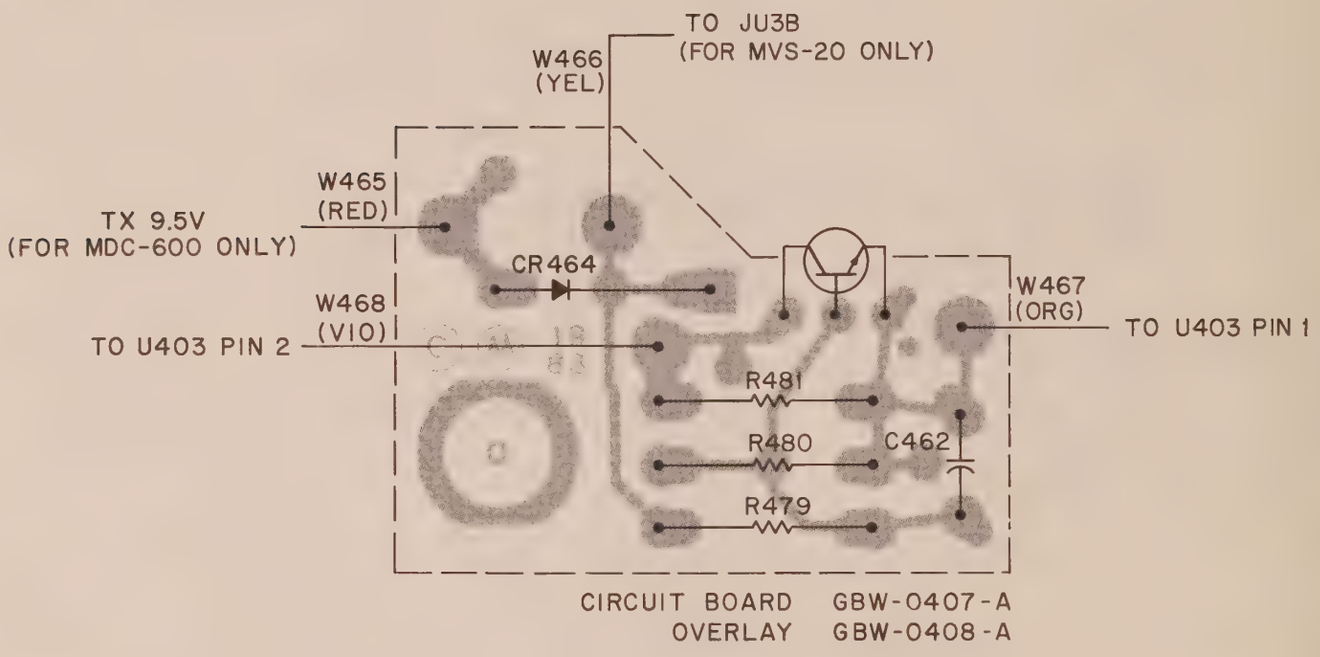
HLN4373A *SYNTOR* Retrofit Board — MXW-0433-O

| REFERENCE SYMBOL | MOTOROLA PART NO. | DESCRIPTION |
|---|---|---|
| | | **transistor (see note):** |
| Q1 | 48-869642 | NPN; type M9642 |
| Q2 | 48-869648 | NPN; type M9648 |
| | | **resistor Ω ±5%; ¼ W:** unless otherwise stated |
| R1 | 6-11009C69 | 6.8k |
| R2 | 6-11009C49 | 1k |
| R3 | 6-11009C89 | 47k |
| | **non-referenced items** | |
| | 29-83167C01 | STRAIN RELIEF; 4 used |
| | 3-10936A14 | SCREW; 2 used |
| | 4-858060 | RETAINER; 2 used |

**note:** For best results, order diodes, transistors, and integrated circuits by Motorola part number.




GBW-0441-A




# parts list

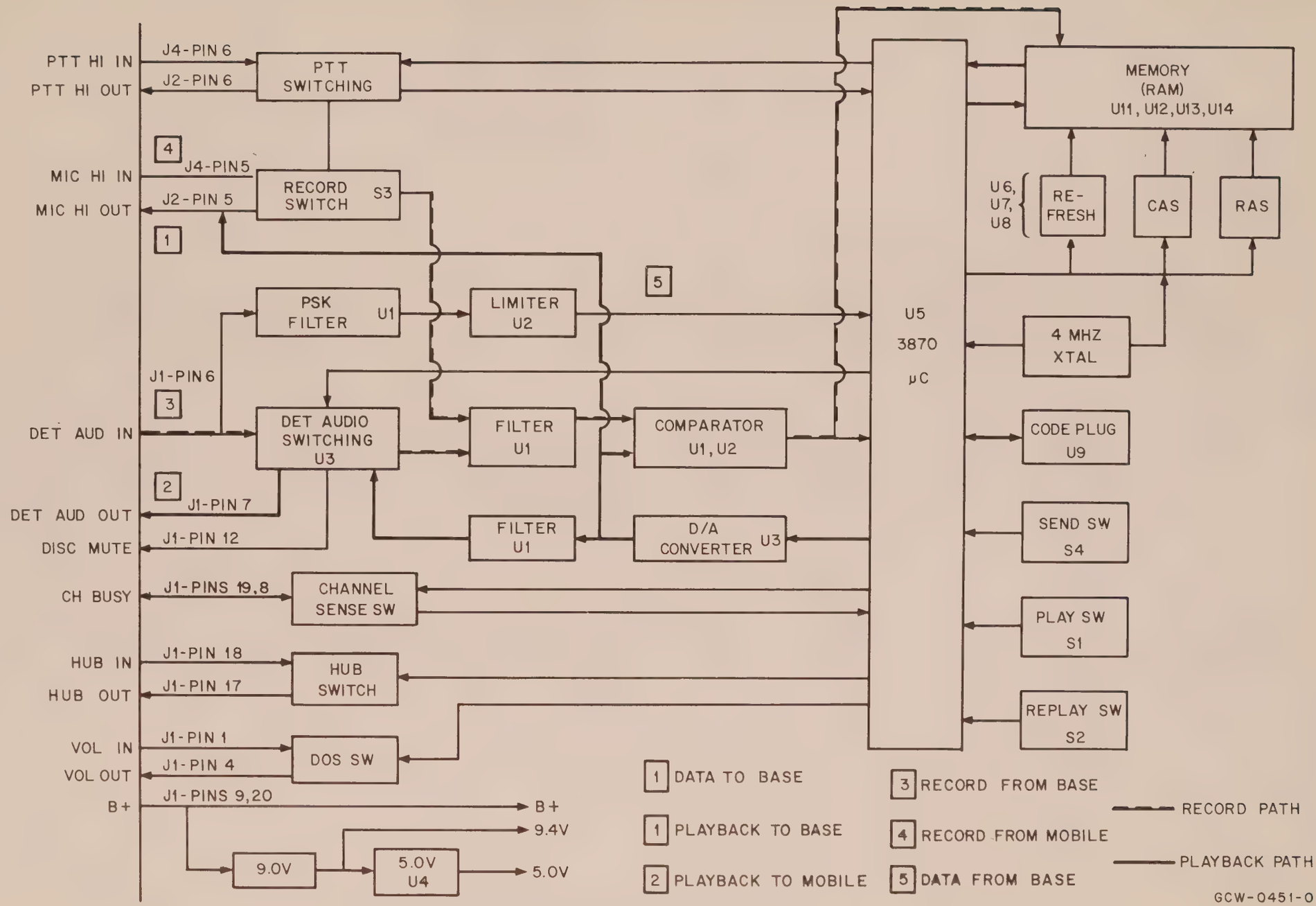
HLN4573A Muting Board — MXW-0434-A

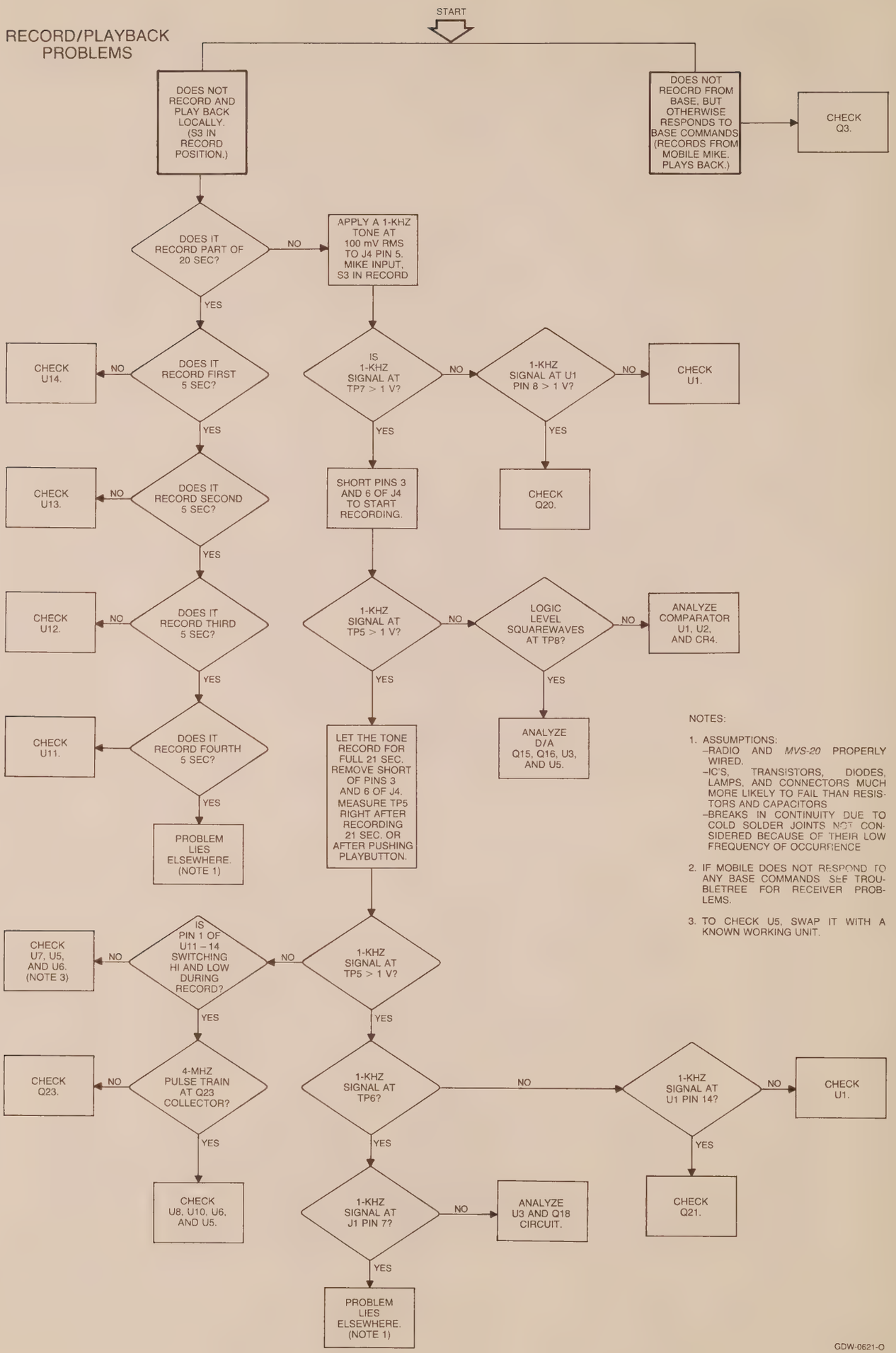
| REFERENCE SYMBOL | MOTOROLA PART NO. | DESCRIPTION |
|---|---|---|
| | | **capacitor:** |
| C462 | 21-83596E10 | 220 pF ±20%; 500 V |
| | | **diode (see note):** |
| CR464 | 48-83654H01 | silicon |
| | | **transistor (see note):** |
| Q466 | 48-869642 | NPN; type M9642 |
| | | **resistor, fixed, Ω ±5%; ¼ W:** unless otherwise stated |
| R479 | 6-11009C99 | 120k |
| R480 | 6-11009C95 | 82k |
| R481 | 6-11009D02 | 150k |
| | | **non-referenced items** |
| | 3-80252F03 | SCREW, tapping; B3.5 x 1.27 x 13 |
| | 4-80149A01 | WASHER, captivated |

**note:** For best results, order diodes, transistors, and integrated circuits by Motorola part number.

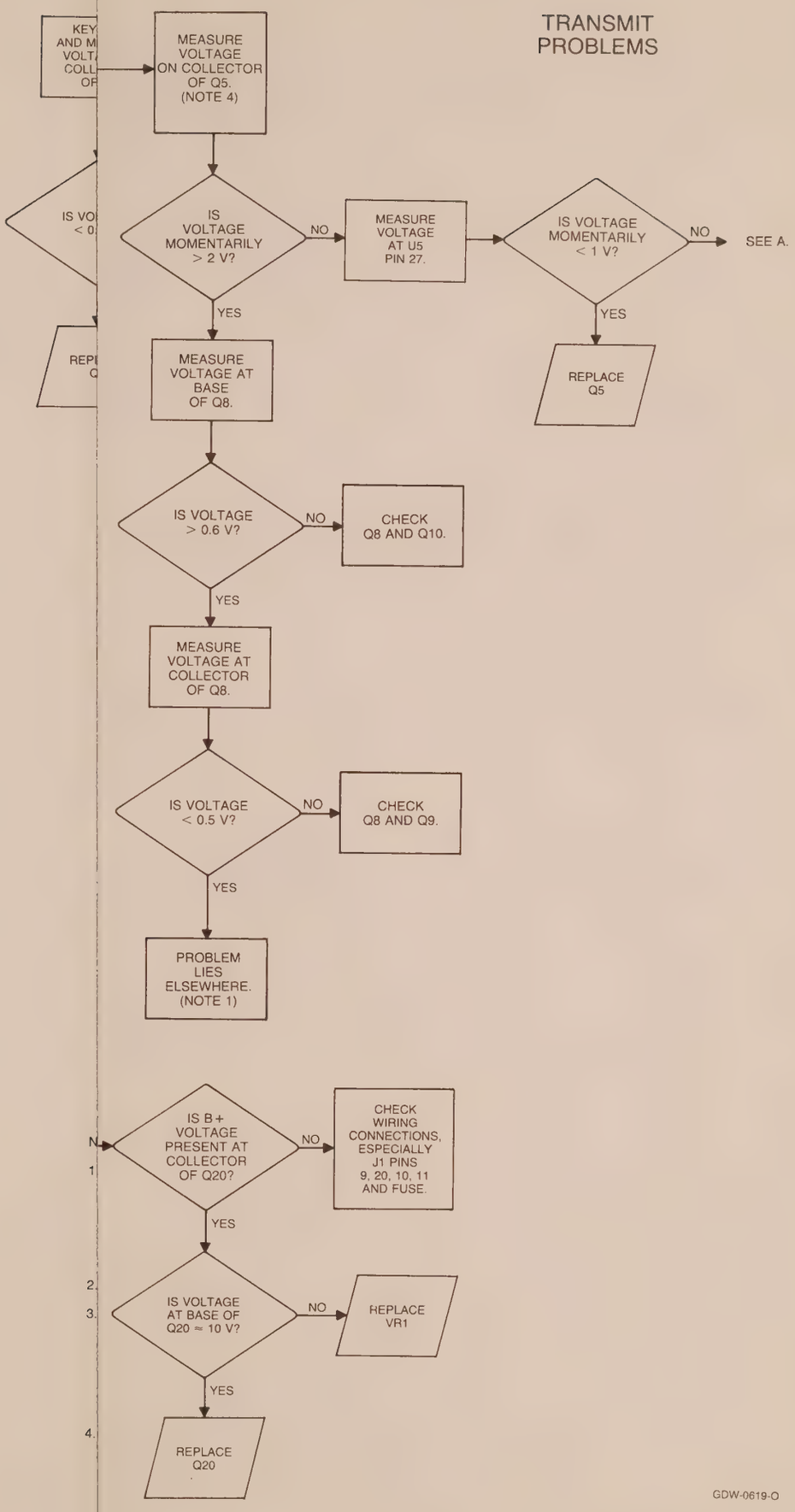
Schematic, Circuit Board Diagram, and Parts List
for HLN4573A *Mitrek* Muting Board
**PAW-0442-A**
6/3/83

# MVS-20 FUNCTIONAL BLOCK DIAGRAM

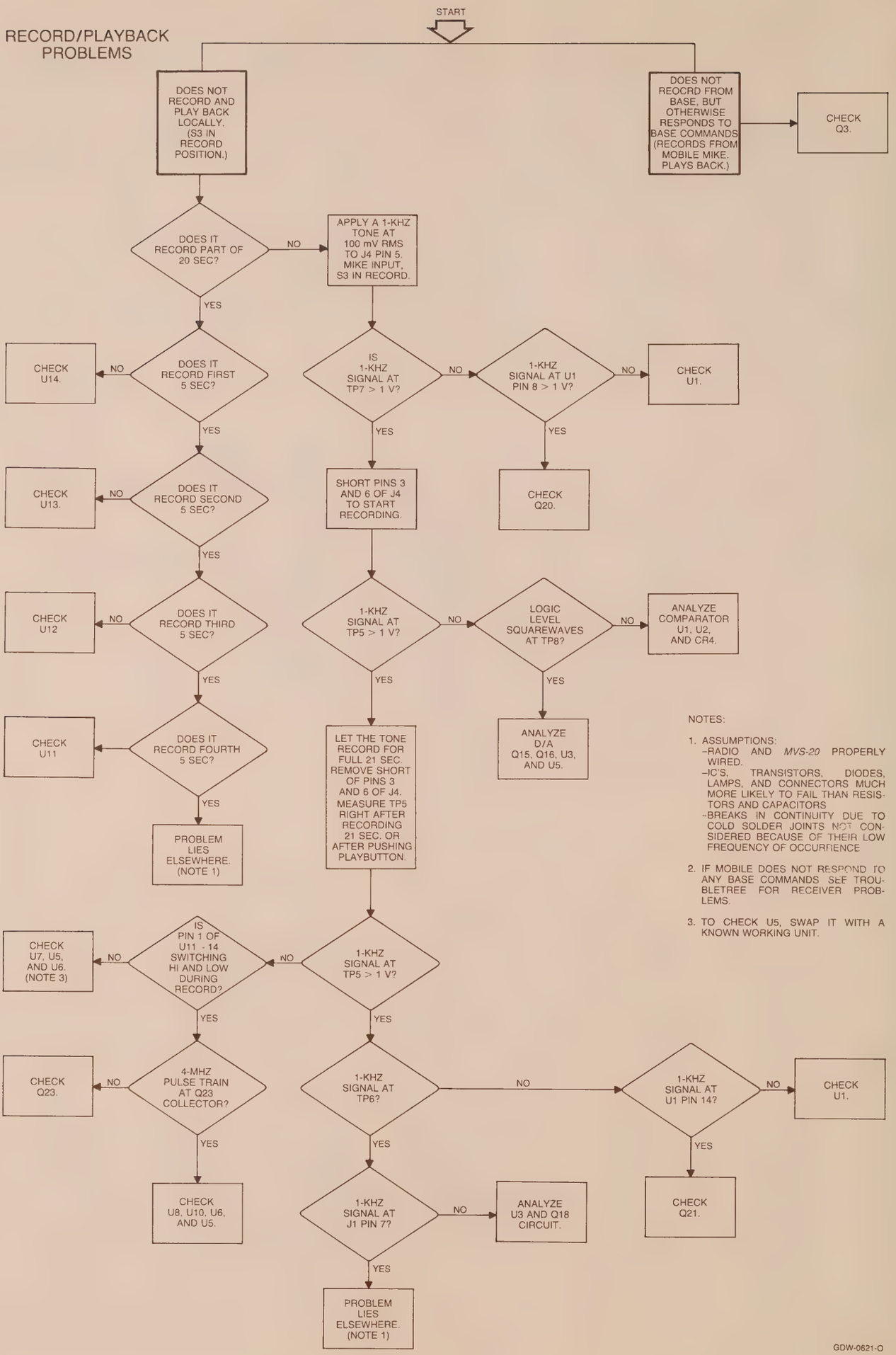





*MVS-20* Record/Playback Problems
Troubleshooting Diagram
**PAW-0655-O**
6/30/83

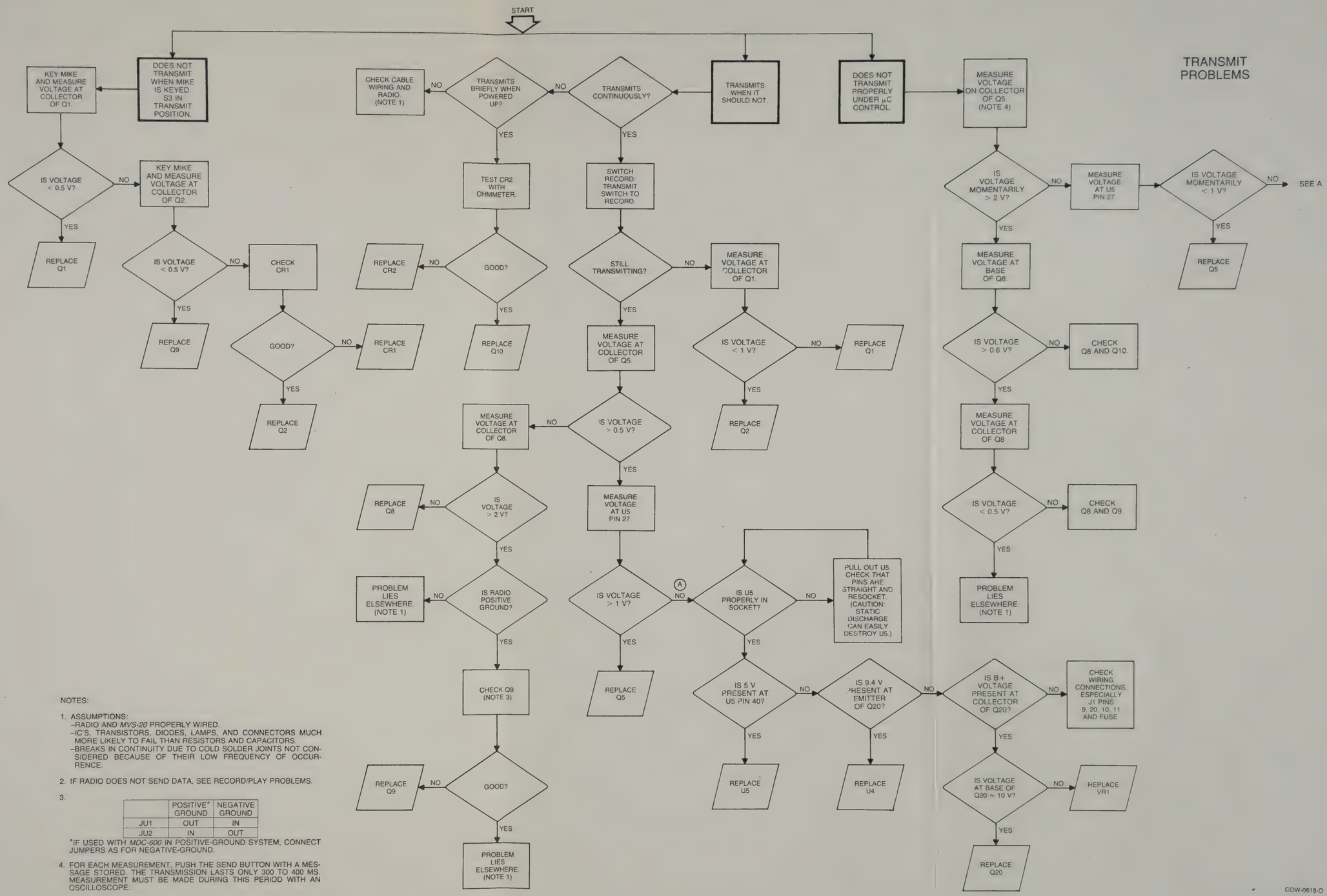



Transmit Troubleshooting Diagram
**PBW-0651-O**
6/30/83




*MVS-20* Record/Playback Problems
Troubleshooting Diagram
**PAW-0655-O**
6/30/83

# TRANSMIT PROBLEMS




NOTES:

1. ASSUMPTIONS:
   –RADIO AND *MVS-20* PROPERLY WIRED.
   –IC'S, TRANSISTORS, DIODES, LAMPS, AND CONNECTORS MUCH MORE LIKELY TO FAIL THAN RESISTORS AND CAPACITORS.
   –BREAKS IN CONTINUITY DUE TO COLD SOLDER JOINTS NOT CONSIDERED BECAUSE OF THEIR LOW FREQUENCY OF OCCURRENCE.

2. IF RADIO DOES NOT SEND DATA, SEE RECORD/PLAY PROBLEMS.

3.

| | POSITIVE* GROUND | NEGATIVE GROUND |
|---|---|---|
| JU1 | OUT | IN |
| JU2 | IN | OUT |

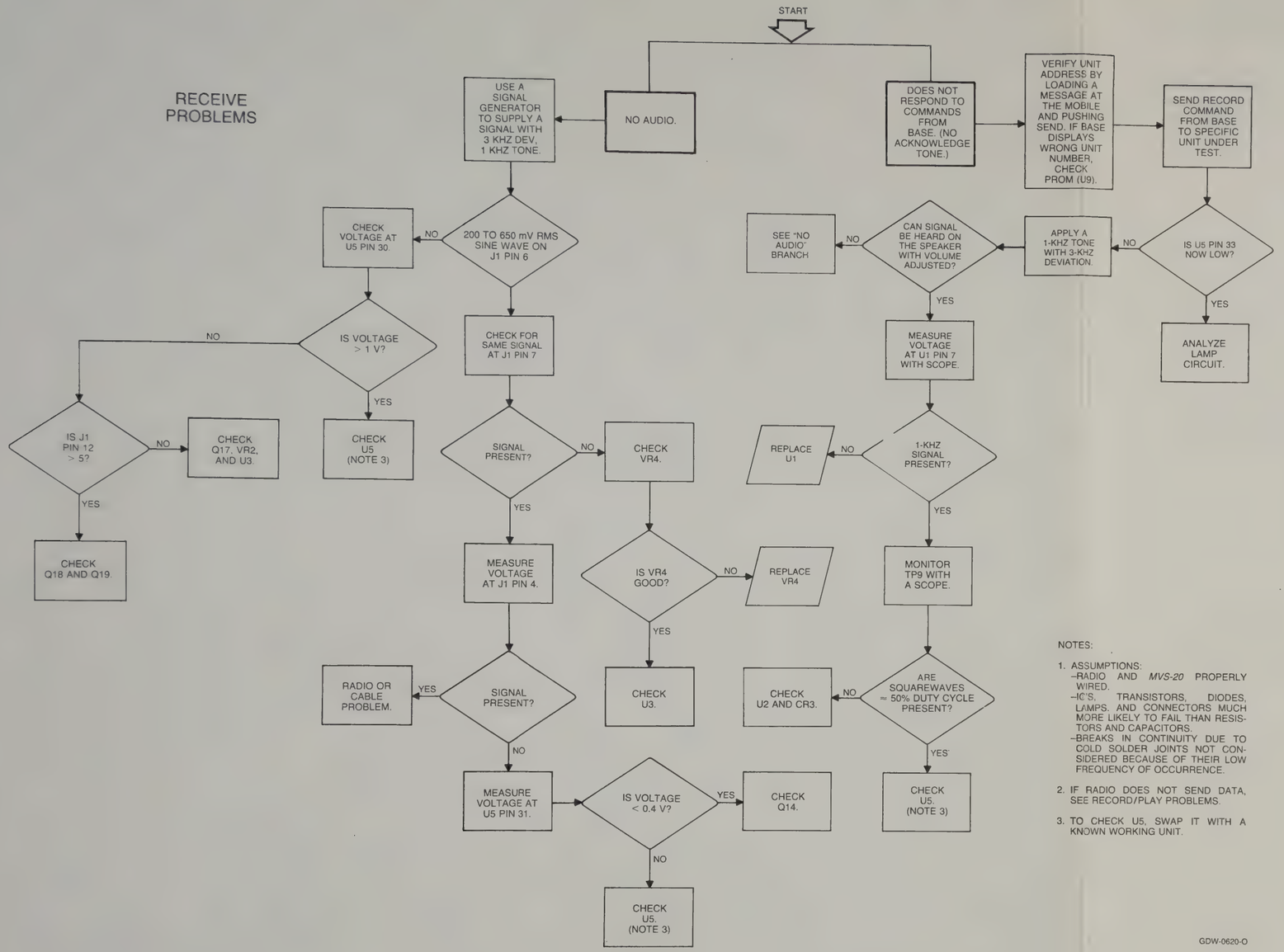
*IF USED WITH *MDC-600* IN POSITIVE-GROUND SYSTEM, CONNECT JUMPERS AS FOR NEGATIVE-GROUND.

4. FOR EACH MEASUREMENT, PUSH THE SEND BUTTON WITH A MESSAGE STORED. THE TRANSMISSION LASTS ONLY 300 TO 400 MS. MEASUREMENT MUST BE MADE DURING THIS PERIOD WITH AN OSCILLOSCOPE.

GDW-0619-O

Transmit Troubleshooting Diagram
**PBW-0651-O**
6/30/83

# RECEIVE PROBLEMS

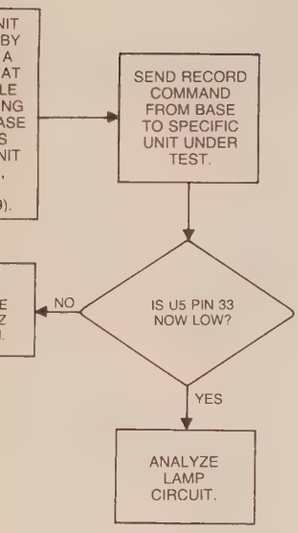



NOTES:

1. ASSUMPTIONS:
   –RADIO AND *MVS-20* PROPERLY WIRED.
   –IC'S, TRANSISTORS, DIODES, LAMPS, AND CONNECTORS MUCH MORE LIKELY TO FAIL THAN RESISTORS AND CAPACITORS.
   –BREAKS IN CONTINUITY DUE TO COLD SOLDER JOINTS NOT CONSIDERED BECAUSE OF THEIR LOW FREQUENCY OF OCCURRENCE.
2. IF RADIO DOES NOT SEND DATA, SEE RECORD/PLAY PROBLEMS.
3. TO CHECK U5, SWAP IT WITH A KNOWN WORKING UNIT.

GDW-0620-O

Receive Troubleshooting Diagram
**PBW-0652-O**
6/30/83




:

UMPTIONS:
DIO AND *MVS-20* PROPERLY
RED.
S, TRANSISTORS, DIODES,
MPS. AND CONNECTORS MUCH
RE LIKELY TO FAIL THAN RESIS-
RS AND CAPACITORS.
EAKS IN CONTINUITY DUE TO
LD SOLDER JOINTS NOT CON-
ERED BECAUSE OF THEIR LOW
EQUENCY OF OCCURRENCE.

RADIO DOES NOT SEND DATA,
RECORD/PLAY PROBLEMS.

CHECK U5, SWAP IT WITH A
WN WORKING UNIT.

GDW-0620-O

GCW-0617-O

Failure-To-Operate
Troubleshooting Diagram
**PEW-0618-O**
6/30/83

FAILURE TO OPERATE

UNIT DOES NOT OPERATE

IS B+ PRESENT AT PIN 20 OF J1

NO

IS B+ PRESENT AT CONTROL HEAD

NO

CHECK WIRING

YES

CHECK SYSTEMS 90 CONNECTION

YES

IS 9.4V PRESENT AT TP3

NO

IS .1UV PRESENT AT Q20 BASE

NO

CHECK R67, VR1, C32

YES

REPLACE Q20

YES

IS 5V PRESENT AT U4 OUTPUT

NO

REPLACE U4

YES

IS 5V PRESENT AT PIN 40 OF U5

NO

CHECK FOR CORRECT INSERTION INTO SOCKET

YES

ARE PINS 20 AND 21 OF U5 AT GND

NO

INSERT PROM INTO SOCKET

YES

IS PROM IN BOARD

NO

REPLACE Y1

YES

DOES Y1 OPERATE AT 4 MHZ

NO

REPLACE U5

YES

DOES PIN 7 OF U5 HAVE STROBE PULSE ON IT

NO

DOES PIN 39 OF U5 REMAIN AT 5V

NO

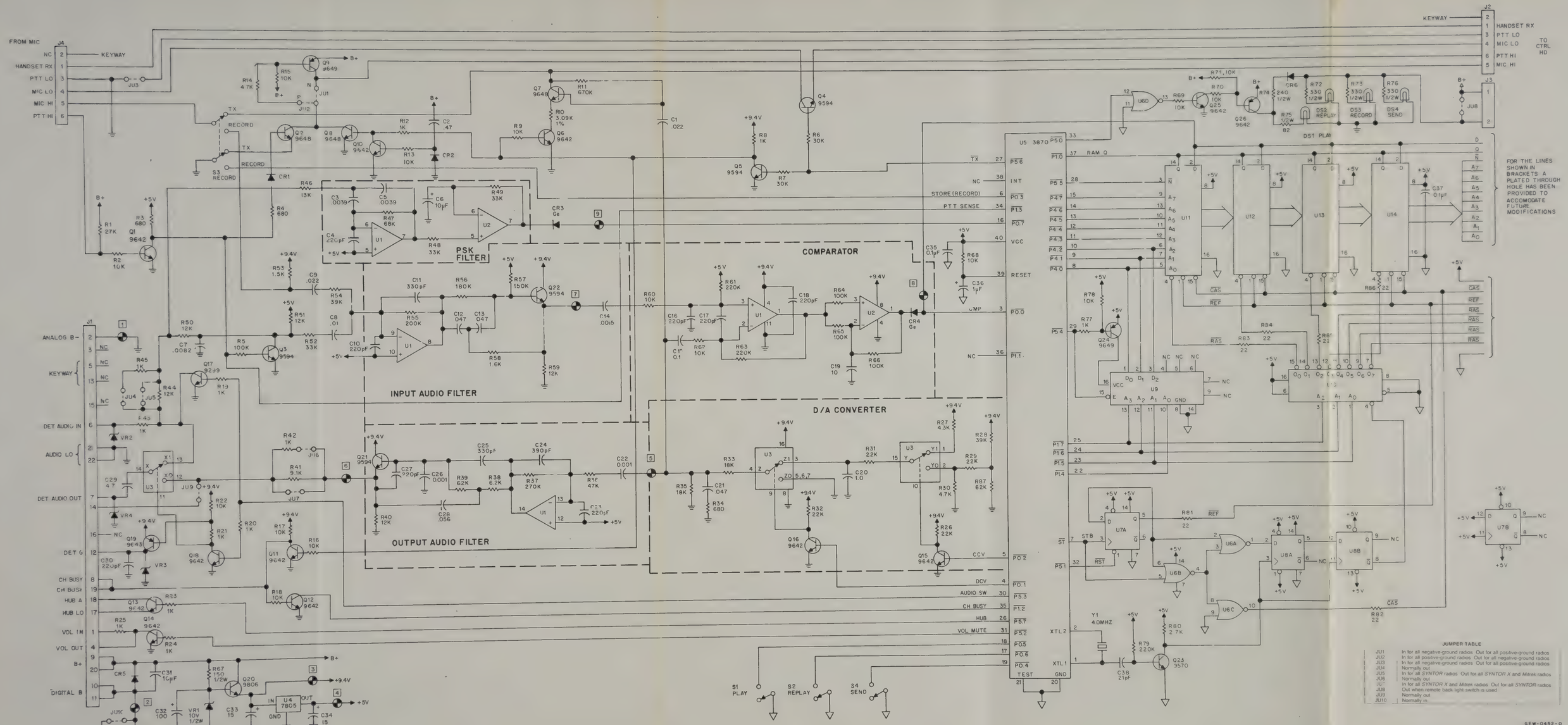
CHECK C35 AND R68

YES

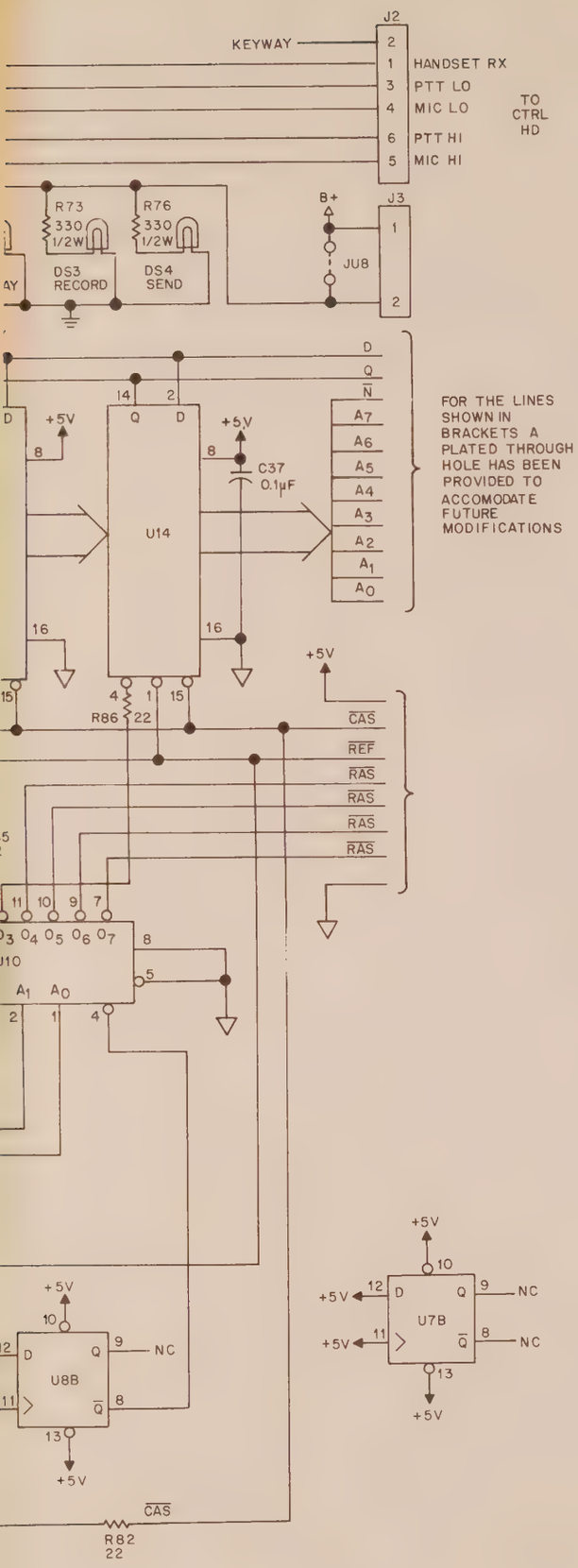
GO TO SPECIFIC PROBLEM TROUBLE-SHOOTING CHART

GCW-0617-0

Failure-To-Operate
Troubleshooting Diagram
**PEW-0618-O**
6/30/83



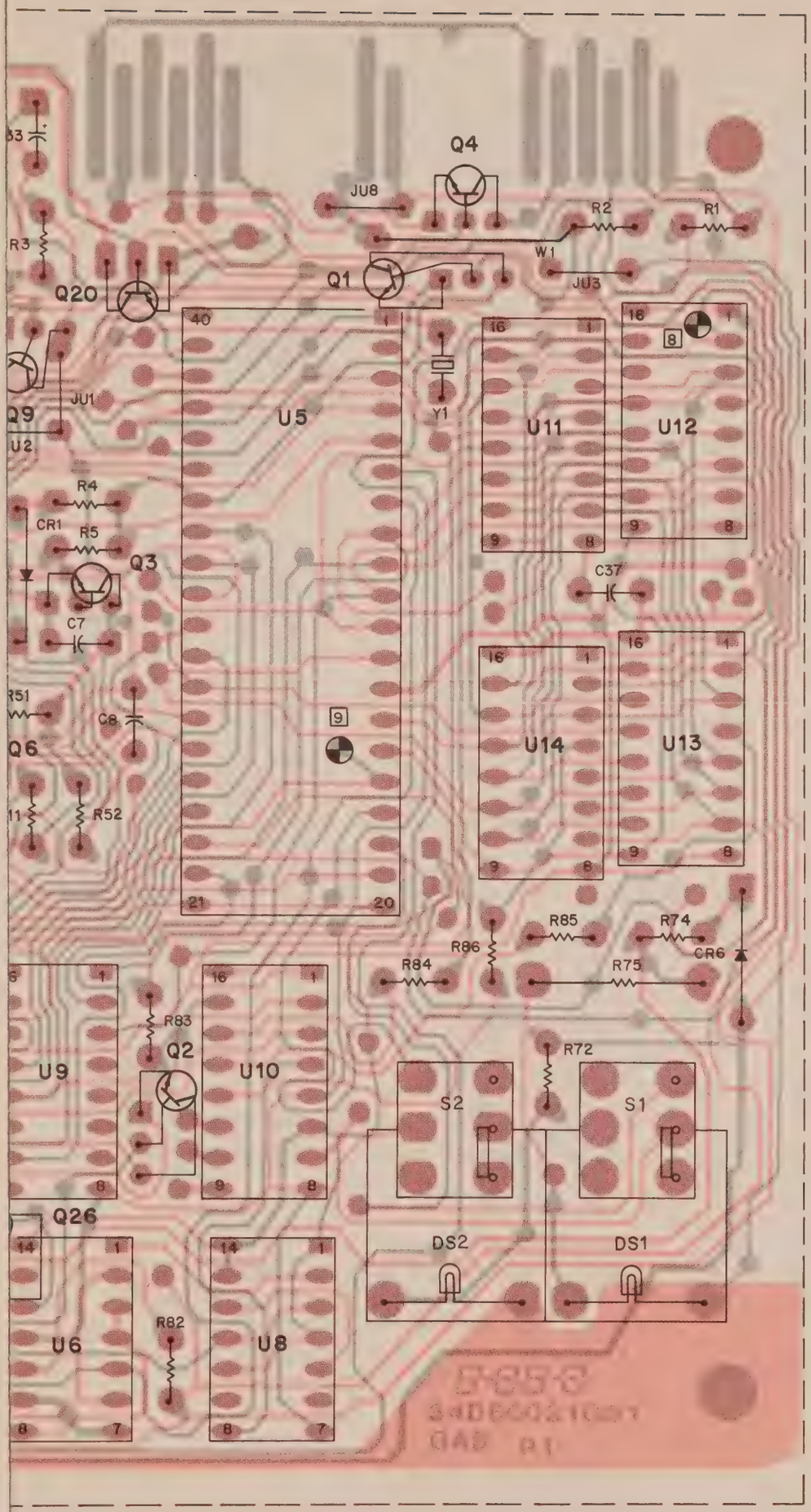

Schematic, Circuit Board Diagram, and Parts Lists
for *MVS-20* Mobile Unit
**PEW-0653-O**
(Sheet 1 of 2)
6/30/83




JUMPER TABLE

| | |
|---|---|
| JU1 | In for all negative-ground radios. Out for all positive-ground radios. |
| JU2 | In for all positive-ground radios. Out for all negative-ground radios |
| JU3 | In for all negative-ground radios. Out for all positive-ground radios |
| JU4 | Normally out |
| JU5 | In for all *SYNTOR* radios. Out for all *SYNTOR X* and *Mitrek* radios |
| JU6 | Normally out |
| JU7 | In for all *SYNTOR X* and *Mitrek* radios. Out for all *SYNTOR* radios |
| JU8 | Out when remote back light switch is used |
| JU9 | Normally out. |
| JU10 | Normally in. |

GEW-0452-0




SOLDER SIDE
GDW-0455-O

COMPONENT SIDE
GDW-0456-O

OVERLAY
GDW-0457-O

3 TEST POINT (VOLTAGE OR WAVEFORM) SEE SCHEMATIC DIAGRAM

Schematic, Circuit Board Diagram, and Parts Lists
for *MVS-20* Mobile Unit
**PEW-0653-O**
(Sheet 2 of 2)
6/30/83

# parts list

HKN4145A Cable Kit — PXW-0409-O

| REFERENCE SYMBOL | MOTOROLA PART NO. | DESCRIPTION |
|---|---|---|
| | | **non-referenced items** |
| | 14-84556B13 | CONNECTOR, housing; dark blue |
| | 9-84151B03 | CONTACT, receptacle |

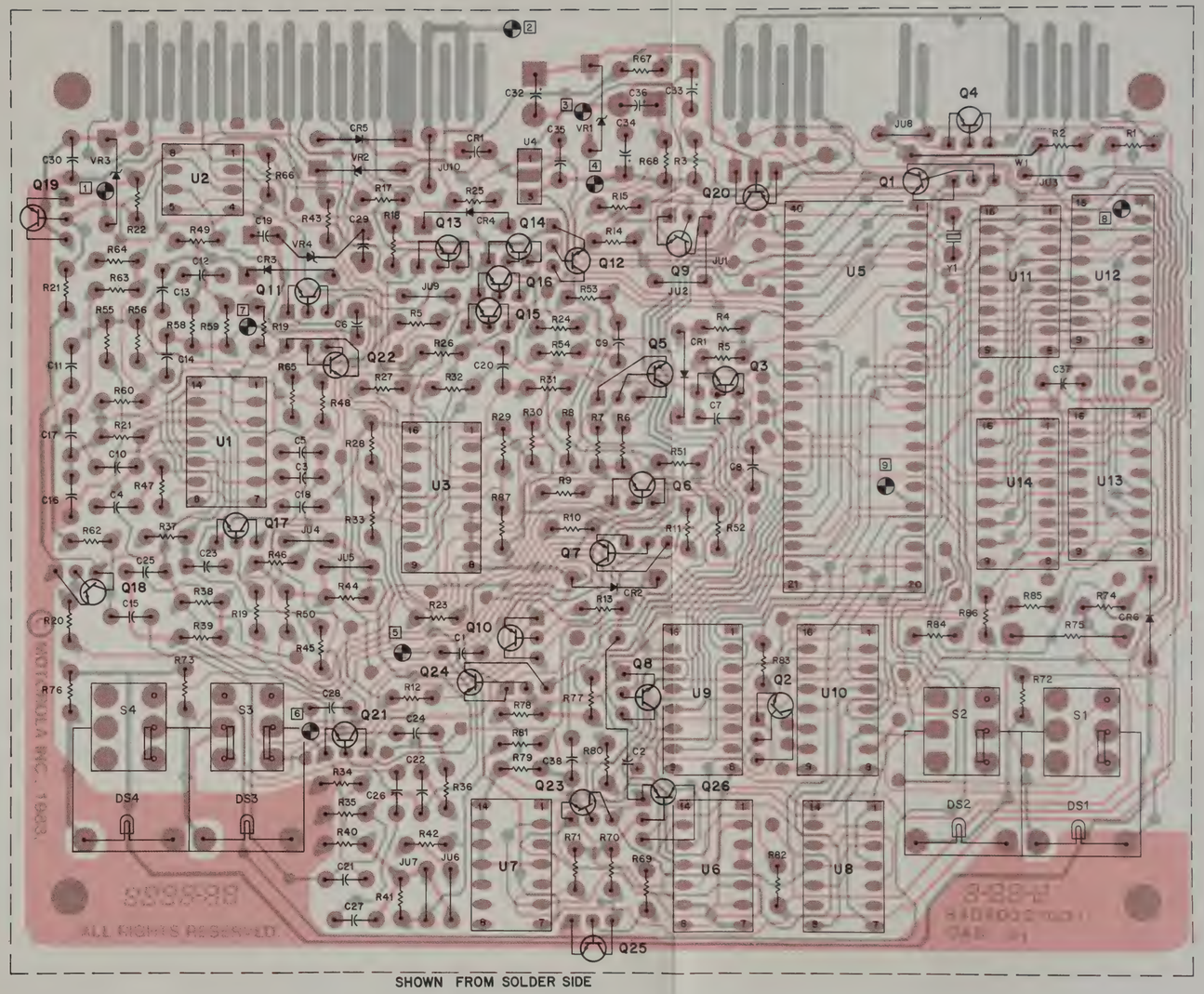
HLN4535A Mobile Voice Storage Circuit Board — PXW-0410-O

| REFERENCE SYMBOL | MOTOROLA PART NO. | DESCRIPTION |
|---|---|---|
| | | **capacitor, fixed, μF ±5%, 50 V** unless otherwise stated |
| C1 | 8-11017A11 | .022 |
| C2 | 23-84762H14 | .47 |
| C3 | 8-11017A16 | .0039 |
| C4 | 21-11015B05 | 220 pF ±10%, 100 V |
| C5 | 8-11017A18 | .0039 |
| C6 | 23-84665F01 | 10 +100, −10%, 25 V |
| C7 | 8-11017A25 | .0082 |
| C8 | 8-11017A08 | .01 |
| C9 | 8-11017A4 | .022 |
| C10 | 21-11015B05 | 220 pF ±10%, 100 V |
| C11 | 21-84494B16 | 330 pF |
| C12, 13 | 8-11017A06 | .0047 |
| C14 | 8-11017A02 | .0015 |
| C15 | 8-11017A17 | .1 |
| C16 – 18 | 21-11015B05 | 220 pF ±10%, 100 V |
| C19 | 23-84665F01 | 10 +100, −10%, 25 V |
| C20 | 23-11013D01 | 1 ±10%, 20 V |
| C21 | 8-11017A14 | .047 |
| C22 | 8-11017A01 | .001 |
| C23 | 21-11015B05 | 220 pF ±10%, 100 V |
| C24 | 21-11015B08 | 390 pF |
| C25 | 21-11015B07 | 330 pF ±10%, 100 V |
| C26 | 8-11017A01 | .001 |
| C27 | 21-11015B05 | 220 pF ±10%, 100 V |
| C28 | 8-11017A15 | .056 |
| C29 | 23-84665F05 | 4.7 ±10%, 25 V |
| C30 | 21-11015B05 | 220 pF ±10%, 100 V |
| C31 | 23-84665F01 | 10 +100, −10%, 25 V |
| C32 | 23-84665F03 | 100 ±10%, 25 V |
| C33, 34 | 23-84538G23 | 15 ±20%, 20 V |
| C35 | 8-11017A08 | .01 |
| C36 | 23-84665F04 | 1 ±10% |
| C37 | 8-11017A17 | .01 |
| | | **diode (see note)** |
| CR1, 2 | 48-82466H13 | silicon |
| CR3, 4 | 48-82178A06 | germanium |
| CR5, 6 | 48-82466H13 | silicon |
| VR1 | 48-82256C28 | zener, 10 V, 1 W |
| VR2 – 4 | 48-82256C50 | zener, 24 V, .4 W |
| | | **integrated circuit (see note)** |
| U1 | 51-84561L75 | quad op amp |
| U2 | 51-80067C14 | dual bimos op amp |
| U3 | 51-82884L65 | triple analog switch |
| U4 | 51-84561L76 | 5 V regulator |
| U5 | 51-97003C05 | 3870 microcomputer with ROM |
| U6 | 51-84561L04 | quad nor gate |
| U7, 8 | 51-84561L34 | dual D flipflop |
| U9 | 51-97000C10 | PROM |
| U10 | 51-84561L41 | decoder/demodulator |
| U11 – 14 | 51-80070C18 | RAM, 64k |
| Y1 | 48-82611M06 | crystal, 4 MHz |
| | | **light** |
| DS1 – 4 | 65-84047E01 | encapsulated lamp |
| | | **resistor, fixed, Ω ±5%, ¼ W** unless otherwise stated |
| R1 | 6-11009E83 | 27k |
| R2 | 6-11009E73 | 10k |
| R3 | 6-11009E53 | 1.5k |
| R4 | 6-11009E55 | 1.8k |
| R5 | 6-11009E97 | 100k |
| R6, 7 | 6-11009E84 | 30k |
| R8 | 6-11009E49 | 1k |
| R9 | 6-11009E73 | 10k |
| R10 | 6-10621C42 | 3.01k |
| R11 | 6-11009F14 | 470k |
| R12 | 6-11009E49 | 1k |
| R13 | 6-11009E73 | 10k |
| R14 | 6-11009E65 | 4.7k |
| R15 | 6-11009E73 | 10k |
| R16 – 18 | 6-11009E73 | 10k |
| R19 – 21 | 6-11009E49 | 1k |
| R22 | 6-11009E73 | 10k |

PXW-0410-O (2)

| REFERENCE SYMBOL | MOTOROLA PART NO. | DESCRIPTION |
|---|---|---|
| R23 – 25 | 6-11009E49 | 1k |
| R26 | 6-11009E81 | 22k |
| R27 | 6-11009E64 | 4.3k |
| R28 | 6-11009E87 | 39k |
| R29 | 6-11009E81 | 22k |
| R30 | 6-11009E65 | 4.7k |
| R31 | 6-11009E57 | 2.2k |
| R32 | 6-11009E81 | 22k |
| R33 | 6-11009E79 | 18k |
| R34 | 6-11009F18 | 680k |
| R35 | 6-11009E79 | 18k |
| R36 | 6-11009E89 | 47k |
| R37 | 6-11009F08 | 270k |
| R38, 39 | 6-11009E68 | 6.2k |
| R40 | 6-11009E75 | 12k |
| R41 | 6-11009E72 | 9.1k |
| R43 | 6-11009E49 | 1k |
| R44 | 6-11009E75 | 12k |
| R46 | 6-11009E76 | 13k |
| R47 | 6-11009E93 | 68k |
| R48, 49 | 6-11009E85 | 33k |
| R50, 51 | 6-11009E75 | 12k |
| R52 | 6-11009E85 | 33k |
| R53 | 6-11009E53 | 1.5k |
| R54 | 6-11009E87 | 39k |
| R55 | 6-11009F16 | 200k |
| R56 | 6-11009F04 | 180k |
| R57 | 6-11009F02 | 150k |
| R59 | 6-11009E75 | 12k |
| R60 | 6-11009E73 | 10k |
| R61 | 6-11009F06 | 220k |
| R62 | 6-11009E73 | 10k |
| R63 | 6-11009F06 | 220k |
| R64 – 66 | 6-11009E97 | 100k |
| R67 | 6-125A29 | 150, ½ W |
| R68 – 71 | 6-11009E73 | 10k |
| R72, 73 | 6-125A37 | 230, ½ W |
| R74 | 6-125A34 | 240, ½ W |
| R75 | 6-125A23 | 82, ½ W |
| R76 | 6-125A37 | 330, ½ W |
| R77 | 6-11009E49 | 1k |
| R78 | 6-11009E73 | 10k |
| R79 | 6-11009E95 | 82k |
| R80 | 6-11009E61 | 3.3k |
| R81 – 86 | 6-11009E09 | 22 |
| R87 | 6-11009E92 | 62k |
| | | **switch** |
| S1, 2 | 40-84324C02 | pushbutton |
| S3 | 40-84324C01 | pushbutton |
| S4 | 40-84324C02 | pushbutton |
| | | **transistor (see note)** |
| Q1 | 48-869642 | NPN; type M9642 |
| Q2 | 48-869648 | NPN; type M9648 |
| Q3 – 5 | 48-869594 | NPN; type M9594 |
| Q6 | 48-869642 | NPN; type M9642 |
| Q7, 8 | 48-869648 | NPN; type M9648 |
| Q9 | 48-869649 | PNP; type M9649 |
| Q10 – 16 | 48-869642 | NPN; type M9642 |
| Q17 | 48-869299 | NPN; type M9299 |
| Q18 | 48-869642 | NPN; type M9642 |
| Q19 | 48-869643 | PNP; type M9643 |
| Q20 | 48-869806 | NPN; type M9806 |
| Q21, 22 | 48-869594 | NPN; type M9594 |
| Q23 | 48-869570 | NPN; type M9570 |
| Q24 | 48-869649 | PNP; type M9649 |
| Q25 | 48-869642 | NPN; type M9642 |
| Q26 | 48-869643 | PNP; type M9643 |
| | | **non-referenced items** |
| | 75-5295B01 | PAD, crytal base |
| | 9-80269B01 | SOCKET, 16-pin |
| | 9-80269B04 | SOCKET, 40-pin |
| | 28-84269C01 | CONTACT, receptacle; 17 used |
| | 28-84269C02 | CONTACT, receptacle; 15 used |
| | 14-84556B13 | CONNECTOR, housing; dark blue |
| | 9-84151B03 | CONTACT, receptacle |
| | 13-8034B65 or 13-84319C83 | ESCUTCHEON |
| | 38-80157D01 or 38-84321C02 | PUSHBUTTON |
| | 38-80157D03 or 38-84321C01 | PUSHBUTTON; 3 used |

**note:** For best results, order diodes, transistors, and integrated circuits by Motorola part number.




SHOWN FROM SOLDER SIDE

SOLDER SIDE GDW-0455-O

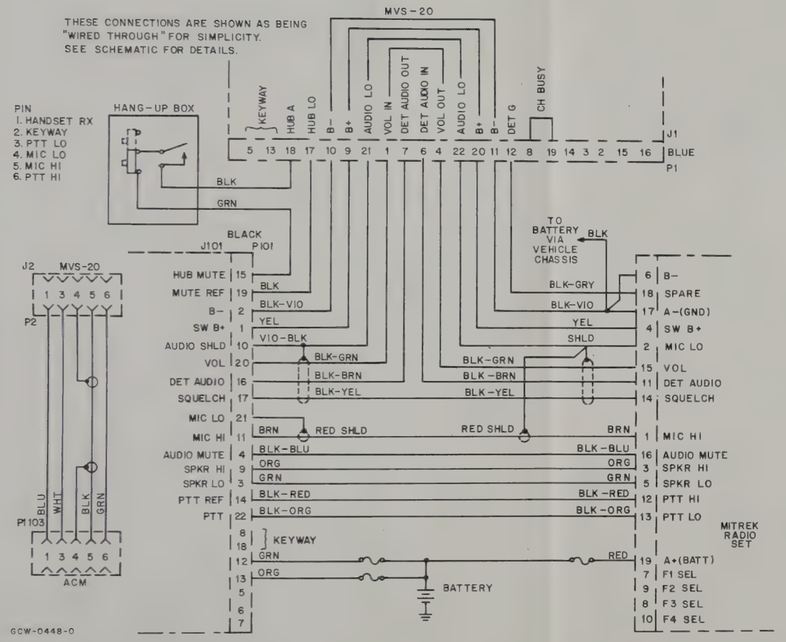
COMPONENT SIDE GDW-0456-O

OVERLAY GDW-0457-O

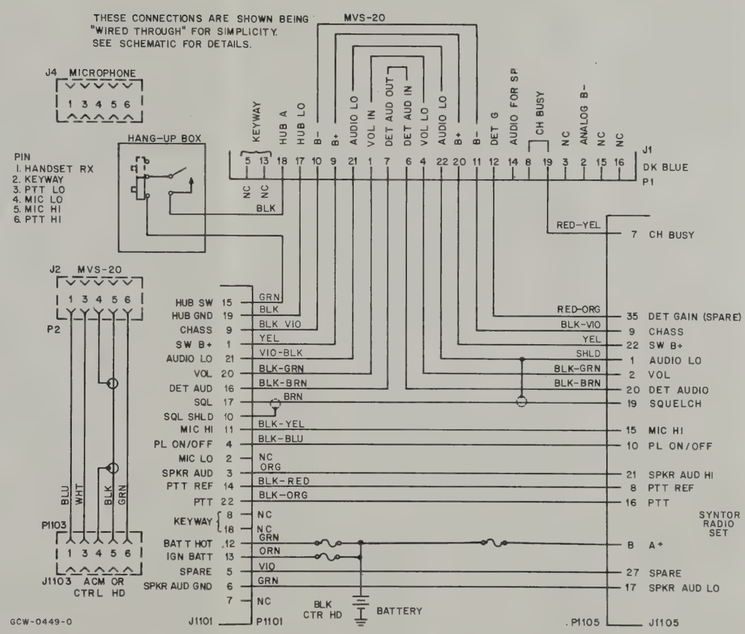
3 TEST POINT (VOLTAGE OR WAVEFORM) SEE SCHEMATIC DIAGRAM

Schematic, Circuit Board Diagram, and Parts Lists
for *MVS-20* Mobile Unit
**PEW-0653-O**
(Sheet 2 of 2)
6/30/83

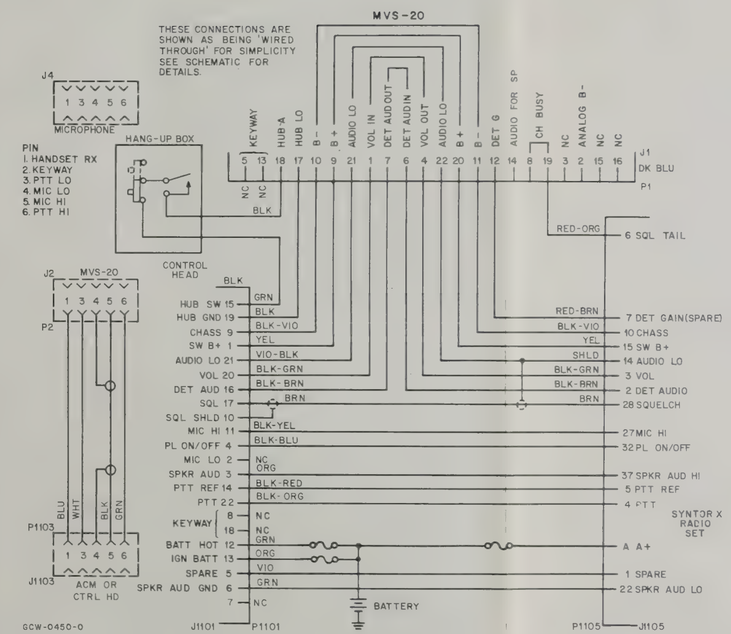
## Mitrek



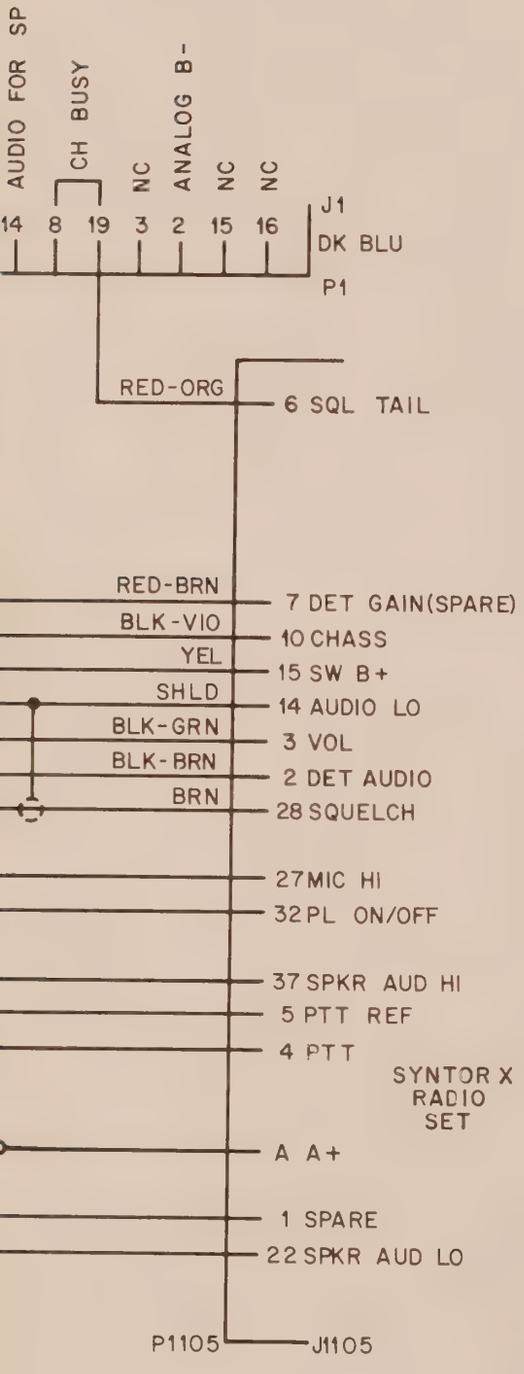

## SYNTOR

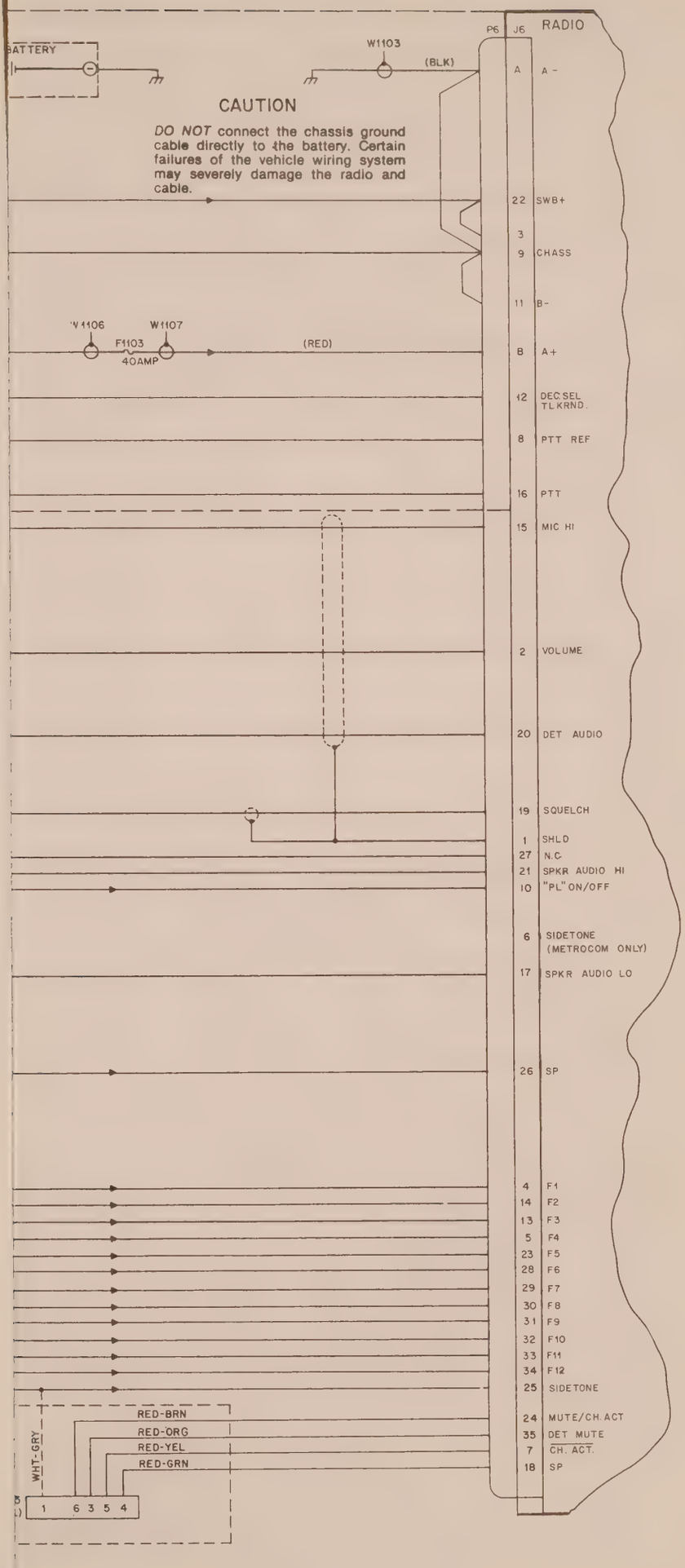



## SYNTOR X

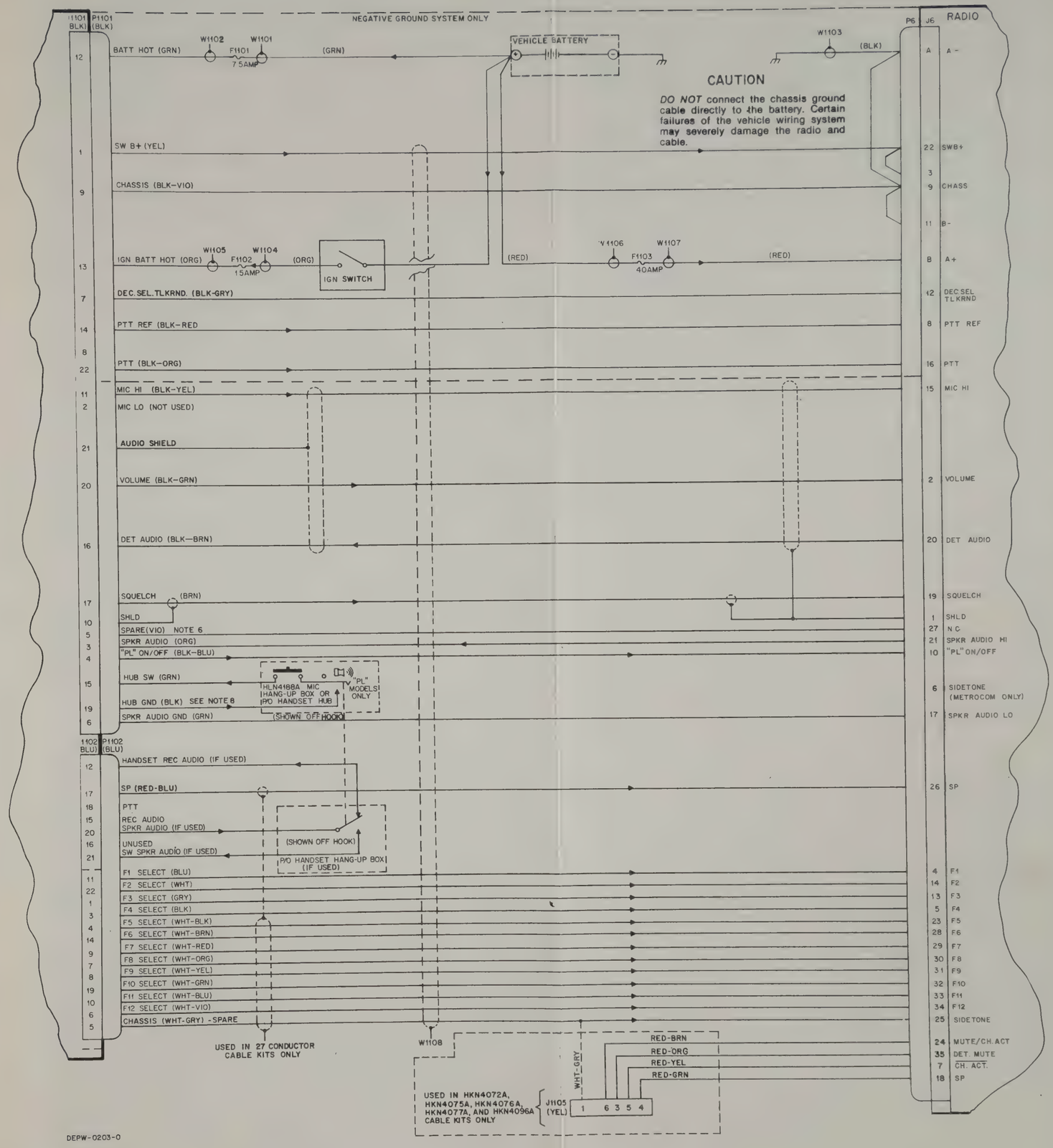



*Mitrek, SYNTOR, and SYNTOR X*
Connection Diagrams
**PEW-0657-O**
6/30/83

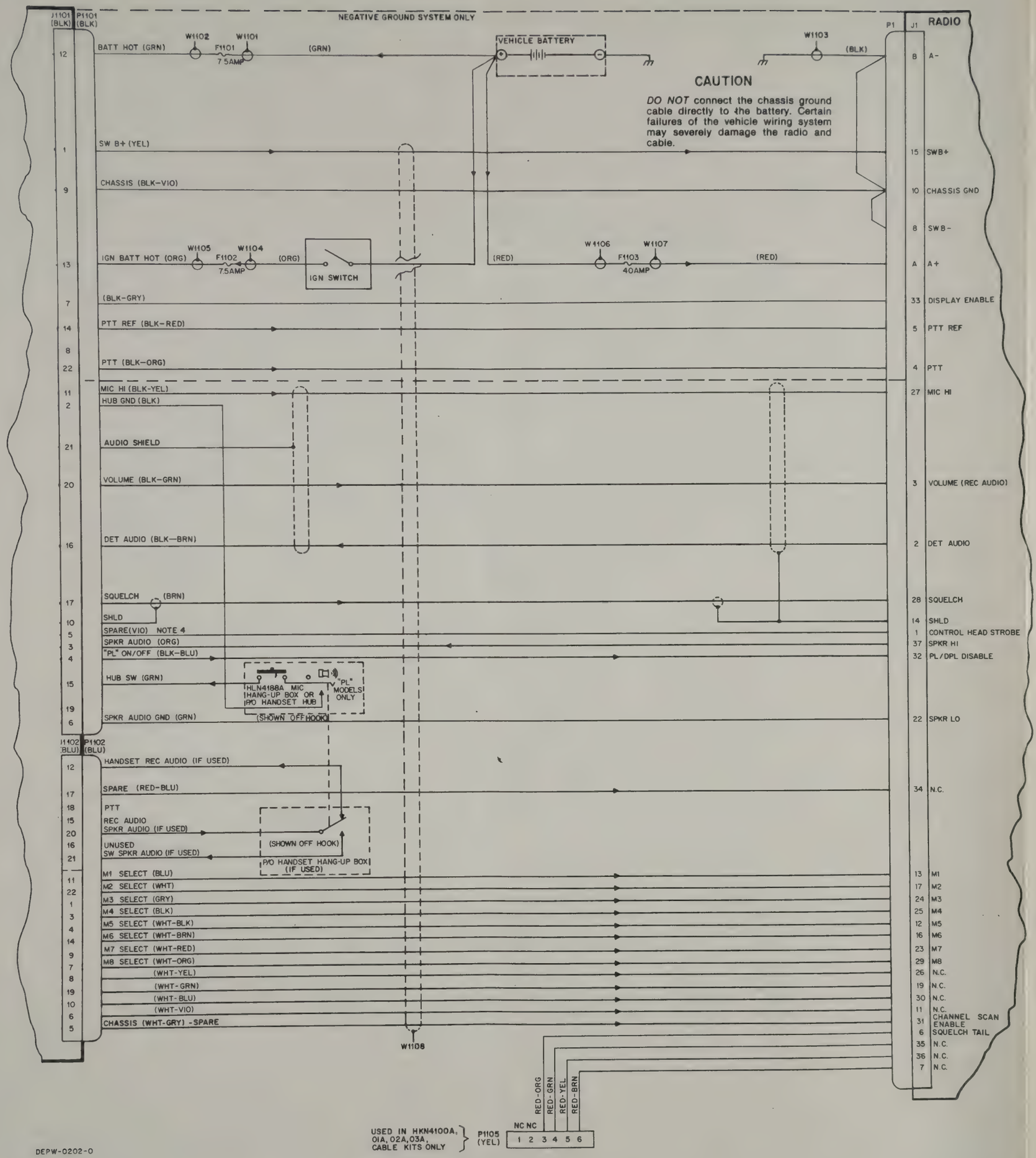

AUDIO FOR SP
CH BUSY
NC
ANALOG B-
NC
NC
14 8 19 3 2 15 16
J1
DK BLU
P1
RED-ORG
6 SQL TAIL
RED-BRN
7 DET GAIN(SPARE)
BLK-VIO
10 CHASS
YEL
15 SW B+
SHLD
14 AUDIO LO
BLK-GRN
3 VOL
BLK-BRN
2 DET AUDIO
BRN
28 SQUELCH
27 MIC HI
32 PL ON/OFF
37 SPKR AUD HI
5 PTT REF
4 PTT
SYNTOR X
RADIO
SET
A A+
1 SPARE
22 SPKR AUD LO
P1105
J1105




*Interconnect Diagram for SYNTOR Cable Kits*
*HKN4075A – 4077A and HKN4096A*
*Motorola No.* ***DEPW-0203-O***
*10/1/82*




*Interconnect Diagram for SYNTOR Cable Kits*
*HKN4075A – 4077A and HKN4096A*
*Motorola No.* ***DEPW-0203-O***
*10/1/82*




*Interconnect Diagram for SYNTOR X*
*Cable Kits HKN4100A – 4103A*
*Motorola No.* ***DEPW-0202-O***
*10/1/82*

MOTOROLA

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with *MDC-600*
Signaling System

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